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THE PROCEEDINGS

OF THE

UNITED STATES NAVAL INSTITUTE.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE EMPLOYMENT OF PETTY OFFICERS IN THE NAVY.*

By LIEUT.-COMMANDER W. F. FULLAM, U. S. Navy.

The Naval Institute does well to invite discussion of the status of petty officers, for it is the one most important subject in connection with the personnel of the navy to-day. This is not putting it too strongly, because it is like a knife that cuts both ways. To elevate the petty officer will not only have the inevitable effect to uplift the bluejacket and improve discipline, but it will so relieve commissioned officers of many little harassing duties that they may be free to devote themselves to the important work that now presses hard upon them.

It is absolutely necessary to push the petty officer forward at a time when the demand for officers cannot be met. It is perfectly possible that the proper development of the petty officer and his assignment to more important duties afloat and ashore may enable us to get along with fewer commissioned officers—particularly in the case of certain shore stations, and many of our small ships which have often been over-officered. By doing this and by increasing and properly utilizing the warrant officers we

*This article was received five months after the second article, written by the same author.

may hope to successfully tide over the next few years and prevent the much-to-be-dreaded expedient of attempting to fill the commissioned grades with ne'er-do-wells or inexperienced appointees from civil life.

There is something quite misleading in the word "training" as it is now applied to our petty officers. Their improvement and the much-to-be-desired change in their status is far less a matter of *training* than of *employment*. They have not lacked training in most respects, but they have seldom been properly employed, *even when their training has been perfect!* It would be disgracefully humiliating for naval officers to admit that with all our schools and ships our enlisted men have not been properly trained or taught in the details of naval drills and exercises! On the contrary our men have, in many respects, been more thoroughly trained from boyhood than the men in any other military branch of the government. But, though quite inexcusable perhaps, it would be nearer the truth to say that we have not properly employed or utilized our petty officers. We have followed too closely the custom of olden times which gave them a very low status in drill and discipline, and the navy has habitually required commissioned officers and midshipmen to perform many duties which properly belonged to petty officers. It is only necessary, therefore, to free ourselves from a very bad custom or habit—to get out of a rut which has brought us to a condition no longer to be tolerated.

To illustrate this point—that it is in the employment rather than in the training of our personnel that we have been neglectful—it is proper to cite the case of midshipmen who, after years of training, have often been restricted to "picayunish duties" which had a stunting effect upon their development after graduation. And only recently I have known instances of warrant officers who after rising through all rates from that of apprentice, graduating from all the "schools" that we have in the navy, might yet be seen standing idly while a lieutenant instructed his division, taking no part in the work and aiding the divisional officer, little, if at all. In one instance a chief warrant officer asked *to be relieved from all duties at drills* in order, as he said, that he might devote himself solely to the work of his department! In these cases there was no lack of training, but these warrant officers had not been properly employed and had con-

tracted habits which made them unwilling assistants in carrying on the most important exercises on board ship. Their status and the manner of their employment had been fixed by past "customs of the service." They possessed all the qualifications of good drill-masters and instructors, but they were the unfortunate victims—like the midshipmen—of a very faulty system of employment.

Under the press of necessity we are now beginning to employ midshipmen and warrant officers more actively in important duties, thus freeing the commissioned officers somewhat. The junior officers will rise to the emergency if we call upon them. So, also, will the petty officer. The latter will reach any standard that is set for him—high or low. The time has now come to set his standard high—as high as possible. This is all we have to do. It is not so much a question of training. We have simply to make better use of him—employ him properly. He is very well trained now, but we have failed to utilize good material by a system which has invited the petty officer to stand listlessly behind the line while the commissioned officer vainly attempts to instruct his men—even recruits—in the rudiments. But now we must stop short. The continuance, or perpetuation, of this system, which has refused to properly employ trained men, would be nothing short of criminal.

I wish to dwell upon this distinction between training and employment, because it is most important. We may train men to perfection, but if after assignment to a ship they are not properly employed, their training goes for naught—they sink to a condition of comparative and willing uselessness—they might as well be untrained. Such has been the case, more or less, in the past with officers, petty officers, and men, for the manner of employment of one class affects that of the others—all have been pulled down. A "strenuous" epoch is now upon us. All hands must turn to—officers and enlisted men—and every individual must do double duty for years to come. Every muscle, every mind, must be properly employed. There must be no prostitution of talents, no neglect to utilize and direct intelligence.

The danger to be apprehended from a misconception of our present condition and of the remedy for it will become real if we do not grasp the substance of this matter. If the service

imagines for one instant that "schools" will be sufficient to secure trained petty officers—if we rely upon schools—we will fail miserably. The graduate, however competent, will remain at the same old level of comparative uselessness unless the ship in commission, the service at large, *gives him the proper employment.* Thus the school would do more harm than good by giving us a false idea of having accomplished something. To be sure, the petty officer's school at Newport is doing good work. It is an excellent thing and should be maintained, but we must remember that it is in the daily routine of the ship that we have the *one* great opportunity to employ and develop petty officers. If we neglect this the school will be of little account. It was always silly for officers to criticise the Naval Academy for the shortcomings of midshipmen. The academy did its work well—far better than the ship, and still better than the critics on board. The training of the midshipman was not neglected, but his employment afloat—the system forced upon him by the officer who contented himself by damning the Naval Academy—was simply stupid and its effect was fatal to the development of the midshipman. Similarly, the petty officer's school at Newport may do its duty to the utmost, and the navy may benefit but little. *The service must do its duty.* These five words, italicized, cover the whole question. The routine of the ship from all hands in the morning till tattoo, the manner of employing men during that time and in the night watches, will alone determine whether or not our petty officers are to be developed.

A few officers, a few ships, can do very little toward bringing about a reform of this kind. As in the case of the school their efforts will be abortive if not sustained by the service. The men regard with no little irritation the attempts by individuals to change the time-worn "customs of the service." They will seek transfer to ships where such "hobbies" are not forced upon them—where their duties are easier, their responsibilities lighter and their pay the same. *All ships and all officers must work on the same line if anything is to be accomplished.* The change in the status of the petty officer can only be brought about by a general order from the Navy Department, and the regulation must be enforced everywhere. The effect of such an order would be electrical. Let the petty officer see that we are in earnest—that a new era has dawned. Let it be required that he shall be pushed

forward to more important duties; that he shall have the same general status as the non-commissioned officer in the army; that he shall assume an important rôle in drills and in the maintenance of discipline. Do this—employ him properly—and the petty officer will at once reach the standard fixed for him.

It is unnecessary to go into details regarding the functions of the petty officer. Officers will know how to utilize and develop him when they get the order to do so. The Bureau of Navigation has in view the publication of a Petty Officer's Drill Book, which will give the men access to all drill regulations, and which will contain much useful information bearing upon their duties afloat. These books should be widely distributed and kept in the canteens of all ships to be sold at the lowest possible price, in order that men may buy and consult them. The drill book will be attractive in form and profusely illustrated. Divisional officers throughout the service should require their petty officers to inform themselves thoroughly upon all points in the drill regulations and should give them every possible assistance and encouragement.

In the case of training ships it is suggested that the *squad system of instruction* be generally followed—the divisions being subdivided into squads, each in charge of a petty officer or seaman who shall be required, under the direction of the divisional officer, to instruct his squad in the rudiments of seamanship, gunnery, signals, etc., and to actively assist the divisional officer at all times. A plan of this kind has been tried, and its success was only limited by the fact that the petty officers, as a rule, had never been so employed before, and for that reason were not up to the standard in all cases. Their improvement was marked, however, and the result was better than that of the system that requires the commissioned officer to do everything—or to vainly attempt to do everything.

The training of the petty officer, as distinguished from his employment, must begin, and indeed be practically finished, before he gets his rate, for the same reason that the training of an officer begins before he gets his commission. The petty officer's training begins when he is an apprentice, or landsman, and it continues while he is a seaman. If the apprentice and seaman have been properly trained the petty officer, when he gets his rate, will be well trained; it only remains to employ him properly.

Of course, he may need some little extra instruction, perhaps, but the statement stands that he simply needs experience and intelligent employment. It is most important, therefore, that we should look to the training of our men as the surest means of securing trained petty officers. This is the foundation. We should not attempt to build upon the sand—pin our faith to a school after school days are over, progress backward. Generally speaking, our enlisted men are pretty well employed, but not so well trained. The man needs better training; the petty officer needs proper employment. Each will help the other. These two conditions are mutually dependent. If the *man* is required to be quick, respectful, exact, and attentive, the petty officer will have been brought up the right way—he will have been properly trained. And if the petty officer is made an important factor in the ship, the men brought up under such a system will have the right idea of a petty officer's position, and they will reach a higher standard when they in turn are rated.

There is no little criticism nowadays of the training of our enlisted men. They are not quick enough. The modern ship with its many compartments makes it more difficult to control men and keep them moving. Hence the necessity for good petty officers in all parts of the ship. Our boats are not used enough, and the men do not pull a very good oar. In this connection I wish to quote from a recent letter received from a brother officer who discusses this question and compares the activity of our men with that of the crews of certain foreign men-of-war with which he has been in company. He says: "Every boatswain's call is answered by all concerned on the run and instantly. A boat is called away, and before the pipe is done you can see the crew all on the run. They jump to their thwarts, and before they have well sat down the boat is dropping. It is little over thirty seconds from the call until the boat is pulling off around the ship, and this in a heavy swell. Their boats are wider, heavier and better rigged than ours. They are constantly at work under oars and sail." It will not be denied that men trained in this manner are likely to make good petty officers. After such training an intelligent system of employment will secure efficiency.

There is no duty which tends so surely to cultivate in men a high sense of responsibility—to make them strict, attentive, and

military—as guard and sentry duty. It is most remarkable that the enlisted men of the navy have been deprived of this valuable experience by their own officers, who fully realize, or should realize, its importance. We talk of training our men, of their faults and shortcomings, and then we deliberately refuse to give them the work in naval routine which would most surely correct their faults! If it is possible to give both men and petty officers any experience in guard duty it should be done by all means. If we are interested in the training of our men, *let us train them.*

It is unnecessary to dwell upon this subject. All officers are agreed upon it, and have been for years. There is nothing new in this paper—little that one does not hear every day in conversation. The only reason or excuse the writer can give for assuming to discuss the matter is that three years' experience recently in the training service teaches the more plainly our great need of good petty officers, for without them our enlisted men cannot be brought to the proper standard of efficiency.

Enough has been said; enough has been written—too much, in fact. It remains to—*do something*.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE TRAINING OF LANDSMEN FOR THE NAVY.

By Lieutenant-Commander W. F. FULLAM, U. S. Navy.

In venturing to comment upon a subject which is, very rightly, receiving much attention just at present, I shall confine myself to the training of landsmen, in which work I have been engaged for nearly three years on board the Lancaster.

It should be recognized, in the first place, that a system of training at any time must be based primarily upon the immediate necessities of the service at large—not upon ideals. We must not simply dream of the past or the future, but we must think of the present and give practical considerations full sway. We must note the one governing fact that officers, petty officers, and men in large numbers are needed *immediately* for general service, and that this demand will not be supplied for several years to come. Evidently, then, the best system of training for us *to-day* is the one which will get, keep, and graduate into the service the greatest number of recruits in the shortest possible time, and which, while doing so, *will divert from general service the smallest number of trained officers, petty officers, and seamen.* To do this, the true functions and the necessary practical work of the training service should be carefully considered and kept within reasonable limits.

Quite apart from the consideration of present necessities, it is submitted that there is such a thing as carrying the training process too far, or attempting to carry it so far that failure is inevitable. The routine and course of instruction may be very exhaustive and impressive on paper; but the graduate may not impress us to the same extent except perhaps in the matter of exhaustion. It would be wiser to teach him fewer things—the

few things that an ordinary seaman most needs to know—and teach these with more practical thoroughness. The recruit should not have that hopeless, hunted, haunted expression, that feeling of fatigue, we sometimes note. Too much training makes a man mad. It may drive him out of the service before he knows what the life in the navy really is, or what it offers him. Nor is it wise to keep large bodies of recruits herded together for many months. Far better distribute them as soon as possible. If the foundation has been properly laid—if they have been well instructed in the rudiments—*they will develop more rapidly by bringing them in touch with the service as soon as practicable.* It is utterly absurd to talk of giving a young farmer the "sea habit" in the training service. He is needed in general service before he can get any such habit—if men ever get it. It is an "iridescent dream." And if we attempt to "train" it into him by a long nagging process, with all the discomforts and deprivations afloat that can be devised by a careful study of the past and a stony indifference to the present, we will train American lads out of the navy instead of enticing them to remain in it. Many will desert in disgust. *Presumably the main object is not only to get men, but to keep them.*

It is, therefore, of the utmost importance that we should shorten and brighten the life on board training-ships as much as possible. A band contributes not a little pleasure, but other things will help. Above all, we must *remove all sense of imprisonment*, and give as much shore leave as practicable. Work and drill the men if we choose from colors in the morning until three o'clock in the afternoon, and then send a watch or quarter watch on shore until time for the morning evolution next day, and the best results, the most contentment, and the nearest approach to success in teaching the "sea habit" will be attained. Restriction to a ship for long periods leads to all sorts of excesses when liberty comes. Even officers who remain too much on board are injured thereby both physically and mentally.

And in this connection the question may well be asked, why is it so difficult for officers or men to get ashore or to get back to a ship? Why are not ship's boats used more? If they were, *more men would know how to pull a good oar*, or to run a steam cutter, and they would get up their muscle, too. There is no better drill or exercise imaginable. Let it be regarded as a

drill—here is a happy solution, which may remove the objection to using a man-of-war's boats. It would be a good thing if there were a regulation compelling every ship in the navy to send a boat ashore, under ordinary circumstances, every hour from 6 A. M. until midnight. *It has been done—with excellent results.* It tends to rob going to sea of many discomforts, both for officers and men.

It must not be forgotten that the business of training landsmen is heart-breaking work. No sooner is one draft broken in than they are sent away and a green draft arrives. There must be some hope, some compensation, for officers and petty officers engaged in this work. Few enjoy it. It is a constant grind—the conditions are far more irksome than in general service.

In a recent paper on the training-ship, Lieutenant Beach of the navy very properly divided the training of seamen into three periods: 1. The barracks; 2. The training-ship; 3. The service. The first two periods must, by the demands of the navy to-day, be *short and "strenuous"*—limited absolutely to instruction in the most elementary, practical and necessary subjects. The work of the shore station and the training-ship should be marked out within certain lines which will accomplish desired results, leaving sufficient play for the intelligent and individual views of commanding officers, and not interfering too much with routine matters which may necessarily be peculiar to each ship or station. An "Office of Naval Training," as proposed by Lieutenant Beach, would be an excellent thing, to systematize the training service and to exercise general control and supervision over the work. But there must not be too much concentration of authority in an office on shore. The office must not rule the ship in little details. The pivot chair must not entirely usurp the functions of the bridge. The "sea habit" should be that commendable habit which induces all naval officers, while on shore at a desk, to *think first of the ship* and to give the ship and the men on board every possible assistance and encouragement, *and give it promptly.*

Admitting for the present that the immediate demands of the service force us to adopt a *short course* of training for landsmen, let us consider how we may shorten this course and how the time may be best employed.

The Barracks.

Before sending the recruit to the training-ship he should be provided with a proper clothing outfit, a ditty box and a rain suit, all very carefully marked. He should be taught to care for his clothes, and to keep his bag and hammock in perfect condition. He should be brought under the strictest military discipline from the start—not coddled at all. He should be well set up, and drilled in the school of the squad and the manual of arms. As soon as he can handle a rifle and revolver—a few days' instruction will quite suffice—*he should be given as much target practice as time will permit.* He should be taught to pull an oar, and should have elementary instruction in knotting and splicing. This period of training need not be longer than one month, or six weeks. I should be glad to receive landsmen on board the Lancaster after this short preliminary instruction on shore. If it is done with thoroughness the recruits will be ready to settle down to the work on board the training-ship.

The Training-ship.

The function of the training-ship should be limited as follows: Get the men aloft as soon as possible, sending them over the masthead first and then out on the yards, the different divisions being finally stationed aloft in *two details*, one to loose and the other to furl for instance, *so that every landsman shall get this exercise.* Teach the recruits how to live on board ship and keep themselves scrupulously clean; to pull a good oar; to heave the lead; to box the compass; knotting and splicing; palm and needle; wigwag, Ardois, and flag signals; the log and sounding machine; anchors and chains; boats under oars and sail; to loose, reef and furl sail; first aid to wounded. The divisional drills should include main and secondary battery, some infantry and single sticks, fire quarters, general quarters, abandon ship, arm and away boats, and collision mat. The draft should have one regular target practice with rifles, revolvers, and great guns during the course, *but it should not be required to give a thorough training in ordnance and marksmanship on board the training-ship.* The course on board the latter, to be *short*, must be *limited* more or less to seamanship and other subjects which cannot be so well taught elsewhere, leaving the cruising ship *its legitimate and*

proper work. The shore stations and the cruising ship *must develop marksmen.* The training-ship must ensure a good physique, and turn out an active, hearty lad who will be found, when he goes to a cruiser, to be up to the work of an ordinary seaman in most respects, and capable of rapid development by his divisional officer in his new environment. If he gets to the cruiser before he is wearied and discouraged, he will think he is progressing, the change of scene and duty will interest him, *and he will be more inclined to remain permanently in the service.*

It may be thought that this period in the training-ship is too short. Experience on board the Lancaster convinces me that it is quite long enough—under a proper system of instruction. If we have fewer training-ships, retaining all the full-rigged and sailing ships, and give to each of these a full complement of officers and petty officers for instructors, more can be accomplished in three months than in six months or a year with many training-ships all having short complements of competent instructors.

In order to expedite the preliminary work, the training-ships, instead of making long or foreign cruises, should be kept in *close touch* with the barracks or shore stations on both coasts, spending not more than one week of each month at sea, and the other three weeks at anchor where the instruction *can be pushed much more rapidly.* The Hartford, Lancaster, Mohican, Essex, Alliance, Topeka and Monongahela, if provided with *full complements* of trained instructors by retiring some of the mastless ships from the training service, could graduate double the number of landsmen, and there could be a great saving in officers and men for the general service. In this connection a proposition by Lieutenant Blue to utilize converted yachts by attaching the latter to the large training-ships is most important. The plan has been followed to a certain extent at one or two shore stations, and it was the intention to use the Wasp at Port Royal in connection with the Lancaster and Topeka to give the men practice at *the helm,* in *heaving the lead,* and at *target practice,* etc. This matter will be referred to again later on.

The Petty Officer as Instructor.

The key to the prompt and proper instruction of landsmen is to be found in the petty officers. Without them much time will be

wasted. It is impossible and impracticable for commissioned officers to personally instruct large bodies of landsmen in the elements of seamanship, etc. Whatever success has been attained on board the Lancaster is due to the fact that the divisions are subdivided into four or six squads, *each squad under the personal charge of a petty officer or seaman, who is required to instruct it in all little details, the commissioned and warrant officers exercising general supervision, assigning the subjects from day to day so that the squads will all get the instruction in turn.* Some excellent squad instructors have been developed. In this work the squad leaders have been supplied with signal cards, compass cards, printed lists of questions, and illustrated plates giving the nomenclature and details regarding sails, anchors and chains, etc. These cards were designed on board the Lancaster, and by request, a large number were printed and supplied by the Bureau of Navigation. A small hand-book of instruction for landsmen has also been printed and distributed on board. It has been suggested to the Bureau, and to the Naval Institute, that an illustrated hand-book for petty officers be issued to the service, containing matter culled from the various drill books—all information needed by a petty officer to enable him to drill a squad, a boat's crew, or gun's crew, etc. *The petty officers of the navy have never been utilized sufficiently in drills and discipline,* and they have had no means of learning their legitimate duties except while on drill. They should be supplied with a hand-book of drills, and be required to pass an examination—to prove themselves competent to drill and instruct a squad—before receiving promotion. In a short time the petty officers throughout the service would recognize their true status, and the divisional officer would receive better support. Training *schools* will not suffice. *The customs of the service at large and the daily routine of cruising ships will alone determine whether petty officers are to be efficient or inefficient.* The order fixing their status, defining their duties, and prescribing their qualifications for promotion must come from the Navy Department, *the fountain head,* to be effective. Then the petty officer will recognize the inevitable. I dwell upon this subject of petty officers *because it is the peg upon which everything hangs in the prompt and thorough instruction of landsmen.*

Type of Training-ship.

Space forbids more than a very brief discussion of this subject. Personally I prefer large full-rigged ships like the Lancaster, with clear open decks where the recruit can be kept *constantly under the eye*, and where a large number can be instructed by a comparatively few line officers. And it is my firm belief that even three months' drill in such a ship, *every effort being made to get the recruits aloft daily*, develops the men physically, makes them fairly active and fearless aloft, and by causing them to use their arms, legs, hands and brains under conditions of some personal danger goes far toward the "formation of character," as expressed by Captain Chadwick. I cannot see that any other method of *physical training* would answer so well, and the moral effect of three months' work of this kind is lasting and invaluable. That we cannot give the men more of it is due to the pressing demands of the service. If we could get brigs, as proposed by Lieutenant Beach, or more full-rigged ships later on, it would be wise to do so. For the *present* we should at least use all the full-rigged and partly rigged ships we have to the best advantage, and give as many recruits as possible the benefits of at least three months of this invaluable training. The opponents of sailing ships should be willing to accept this compromise. If they get the recruit in service in *four months*, in condition to take up the work and drills of a modern ship, they should not object to a training which does so much to produce a good physical development. After all, the most important thing in a man-of-war's man is that he shall be active, handy and fearless. If we start the recruit with these *qualities* he will soon pick up *knowledge* in general service.

Routine of Training-ship.

It is not an easy matter to prescribe a routine that would be in *all respects* applicable to every training-ship, but certain general requirements could be made to which *all* should conform in order to bring the graduated landsmen to the same desirable standard.

With the approval of the Bureau of Navigation, the following general drill routine has been adhered to by the Lancaster for the past six months:

Forenoon.—Cross light yards at colors.

9.20.—Loose sail, for exercise, weather permitting.

9.30 to 11.—Divisional and "all-hands" drills; general quarters, fire quarters, abandon ship, arm and away, collision mat, boats under oars and sail, seamanship and sail drills, battery, single sticks, revolvers and infantry drill.

The drill routine was changed weekly, or every ten days, the drills under each head being "bunched," or repeated, until the men were fairly proficient in each before passing to another.

11.30.—Furl sail. One detail of men having loosed, the other detail would furl, thus getting every landsman in the ship aloft every day.

Afternoon: 1.15 to 3.00.—Squad instruction by the petty officers, the commissioned and warrant officers supervising, in the following subjects: Knotting and splicing, heaving the lead, compass and log, helm, palm and needle, anchors and chains, signals, seamanship, passing boat stoppers, etc.; instruction by surgeon in first aid to wounded.

5.00 P. M.—Evening quarters. Setting-up drill, and marching around the deck, or exercise going aloft and laying out and in on the yards.

6.00 P. M.—Supper.

Sunset.—Send down light yards.

8.00 to 8.30 P. M.—Officers of the deck instructs his division at the Ardois.

Where practicable, send quarter watch on shore at 3.30 P. M. to return at 7 A. M. in time to cross the light yards. The officers having the day watches lower their division boats and send drill crews from their divisions, in succession, to make pulling trips during the day so that all get exercise.

It was the intention to send a division to the Wasp daily at 1 o'clock to return at 6 for supper, the Wasp to be underway, giving the men work at the wheel and hand lead constantly, and at target practice.

As a result of this routine two different drafts of landsmen were, *in my estimation, put in condition for transfer to cruising ships after three months' training on board the Lancaster.* Their development was surprising, particularly in work aloft, and they were sufficiently grounded in divisional drills, at the battery, at

infantry, etc., to fall in with the routine of a cruiser. In connection with this argument in favor of a *short* cruise for landsmen it should be remembered that they are older and more fully developed than apprentices when they enlist, and for this reason they can be brought to the proper standard much easier. For the same reason they chafe under restrictions, and are discouraged by a prospect of many months of training before they can get into general service. *The most that should be attempted by the training service at present should be to bring the recruits as near as possible to the standard of an ordinary seaman.* After the four months' training outlined above at the barracks and in the training-ship, the great majority of the recruits who have come under my observation are much nearer the proper standard of ordinary seamen than the men who are, or have been in the past, enlisted as ordinary seamen for general service. *I should much prefer the graduates of the Lancaster to the ordinary seamen enlisted at receiving-ships. It is for this reason that I advocate a short course of training to meet present emergencies.*

SUMMARY.

To summarize briefly the recommendations contained in this paper:

1. Keep the recruit one month or six weeks at the barracks.

2. Keep the full-rigged, or partly rigged, training-ships in close touch with the shore stations, limiting their course of instruction to three months.

3. Retire some of the mastless training-ships and give the remaining ships better complements of petty officers and instructors.

4. Provide a hand-book for petty officers of the navy, and establish the system of *squad instruction* by petty officers on board training-ships, the officers supervising and naming the subjects for this instruction.

5. Attach one or more converted yachts, as proposed by Lieutenant Blue, to each training-ship. Send a division daily to the yacht at 1 o'clock (after the morning and all-hands drills) to return at 6, the yacht in the meantime being underway giving the men work at wheel and lead and at target practice. After each division has been instructed in this daily routine several times let the yacht take each division in turn for a *week's cruise.*

In a few words, concentrate the instruction upon the essentials—physical development, pulling an oar, heaving the lead, compass, helm, elementary ordnance, infantry, signals, etc., as outlined in the foregoing routine.

Avoid an elaborate and complicated system, and get the landsman on board a cruiser to "acquire information" of modern ships and modern armaments as soon as possible.

After three years' observation and work with landsmen, I am convinced that the plan as outlined would turn out intelligent recruits for the navy. And with proper foresight and thoughtfulness the training-ship, while carrying out a very "strenuous" routine and demanding the strictest discipline, may at the same time bring contentment, satisfaction, and hope to the landsmen who are trained and to the officers and men who are engaged in training them.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

SOME THOUGHTS ON OUR ORDNANCE MATERIAL.

By PROFESSOR P. R. ALGER, U. S. Navy.

It took over 300 years to perfect the two inventions which form the essential features of the modern gun,—to develop the two ideas of breech-loading and rifling to the point of practical efficiency. The breech-loading rifled cannon, built up of steel forgings, and firing elongated steel projectiles with a muzzle velocity as high as 2,000 f. s., was the result of this development. In recent years there has been a great increase in the rapidity of fire of guns, due to gradual improvement in the details of breech mechanism, loading appliances and gun carriages, and a great increase in the power of guns, due primarily to the invention of smokeless powder; but the material and system of construction of the guns have remained unchanged. Is there good reason for this, or will the course of further development lead to the adoption of some other system?

Many think that wire winding, first proposed by Dr. Woodbridge, of Washington, is the coming system. Wire-wound guns, however, though known and experimented with for many years, have never come into general use, and, indeed, until one of their strongest advocates became Director-General of the British ordnance factories, a few years ago, that system of construction had only appeared on the firing ground and not in regular service. At present a certain number of the English guns are wire wound, and it is said that Russia is also making guns of this type. Undoubtedly greater circumferential strength can be obtained by using steel wire in place of hoops, but it is at the expense of comparative weakness longitudinally. Moreover, experience seems to indicate that neither less cost nor less time of manufacture result from the use of wire in gun construction, though these have been claimed as its special advantages.

Not only is the wire-wrapped gun more susceptible to damage from hostile fire, but it is less well adapted to withstand the tremendous shocks and vibrations of discharge than is the gun built up of comparatively few parts of great inertia. When first proposed, wire winding presented features of great advantage, but at present the size and quality of procurable steel forgings are such that the superiority of the wire wound over the built-up gun, either as regards strength, safety, or cheapness, is, at most, trifling, and probably non-existent.

As regards other methods of gun construction, it is not to be doubted that an efficient, cheap and reasonably safe gun can to-day be made of cast steel, or can be forged in a single piece, but the manufacture of such guns can only be defended on the score of cheapness and slightly greater rapidity of production, and they cannot be regarded as in any sense equal to the built-up gun; a single-piece gun can never be as strong and can never be as safe as one built up of forged steel parts, and we cannot afford to put the poorer article on our ships.

From 1880 to 1898 all our guns were designed with chambers of a size to take a brown powder charge of half the projectile weight, which gave a muzzle velocity of from 2,000 to 2,150 f. s., according to the length of bore, while the use of smokeless powder in the same guns added some 300 f. s. to the velocity, without increase of chamber pressure. It was not, however, inability to increase their power which held our guns stationary for so many years,—it was the disadvantages attending any further increase in the weights of powder charges.

The successful development of a smokeless powder made it practicable to take a long step in advance, and it was wisely decided to go at once to a size of chamber and length of bore suitable to smokeless powder charges approaching in weight the former brown powder charges for the same calibres. Accordingly the new model guns, with which all our ships now building are to be armed, were designed to give 3,000 f. s. muzzle velocity with chamber pressures of about 17 tons, and they have all given results on the proving ground which practically equal those predicted for them.

This means a muzzle energy 2¼ times as great as was developed by the old designs using brown powder, and from 60 to 70 per cent greater than that given by the old designs when they

used smokeless powder. This great increase in power, as I have said, has come primarily from the substitution of smokeless for brown powder, but the chances are strongly against there being another similar advance. Smokeless powders are made from the most powerful explosives known, and while further improvements may be made in the direction of increasing their stability and uniformity, any further increase in their power must come from the discovery of a new order of explosives at present unknown to our chemistry.

Of course we can go on increasing velocities with smokeless powder, just as we could have done with the old brown powder, at the expense of increased weights of charge and accompanying increased chamber volumes and lengths of bore, but just as with brown powder we stopped at charges of half the projectile weight, so I think it likely that with smokeless powder we will not go far beyond the same limiting condition.

A few words in regard to the all-important subject of the keeping quality of our smokeless powder will not be out of place. The destruction of a great quantity of this powder at Mare Island a year or more ago was almost beyond doubt caused by spontaneous decomposition. Fortunately, however, there is reason to believe that the cause of that decomposition has been determined and has been removed by the enforcement of more stringent rules looking to the purification of the pyro-cellulose from which the powder is made. Heat tests alone used to be relied upon to prove that proper care had been taken in the processes of manufacture of smokeless powder, but it was found that certain conditions made these tests entirely unreliable, the result being that some insufficiently tested material was accepted and made into powder. It is believed that a repetition of the trouble will be prevented by the methods of inspection and test now in use.

Considering next "Rapidity of Fire,"—the time from fire to fire of any gun under service conditions is made up of two factors, "the loading interval," or the time from one discharge until the gun is again loaded and primed, and the "pointing interval," or the time it takes to get the gun on the target and fire it. It is the first of these factors, the "loading interval," that fixes the "rate of unaimed fire" which is determined on the proving ground, and which depends largely upon the perfection of the breech mechanism and of the loading apparatus.

During the entire course of the modern development of guns, from small arms to the largest cannon, it has been the constant effort of inventors in the field of ordnance to reduce the "loading interval" by mechanical improvements. Almost as constant has been the opposition, on the part of military men, to progress in this direction. It was, and still is, alleged that the "pointing interval" is what really determines the rate of fire in service, and that reduction in the "loading interval" really means nothing but increased waste of ammunition. It is not seen that the less the loading interval the greater the time which may be given to pointing the gun, and that the true way to prevent waste of ammunition is not by the use of imperfect weapons, but by the education of men to properly use perfected ones. In the days when clouds of smoke obscured the target and made the rate of any really aimed fire slow, the argument that there was plenty of time to load between fires, and that nothing could be gained by reducing the loading interval, was fairly plausible, though in fact the quicker the loading the less the chance of missing an opportunity of firing with good aim through the smoke, but now that smokeless powder has come into use it should be clear to all that every unnecessary second used in loading a gun is valuable time lost. Save ammunition by teaching the gun pointers to shoot, not by wasting time which is much more valuable than ammunition.

The extension of the use of metallic cartridge cases from the small arm to larger and larger guns has been the chief factor in the great reduction of the "loading interval" which has been made in recent years. Not only did the brass case permit the use of fixed ammunition, whereby projectile and powder charge are loaded in one motion and no subsequent priming is required, but it was also an efficient gas check, separate from the breech mechanism, so that the latter required no great power to open it. The ordinary forms of gas checks frequently stick after the gun is fired and so prevent the use of a quick-acting breech mechanism, which, operated by a single motion of the hand, has little opening power. The first small R. F. guns all had wedge breech closures, but as the advantages of the brass cartridge case were realized, and its use was applied to guns having the slotted screw breech plug, one after the other 4, 5 and 6-inch rapid-fire guns came into general use, and the metallic cartridge case

was even tried in 8-inch and 10-inch guns. Beyond the 5-inch calibre, however, the advantage of fixed ammunition cannot be realized, because the weight of a complete round becomes too great to be readily handled by a single man, and the moment that improvements in gas checks overcame the difficulty of sticking after each fire, the metallic cartridge case became only a useless extra weight which retards rather than accelerates the rate of fire of the larger calibres. With the 6-inch calibre, and even with the new, high-powered 5-inch gun, the suppression of the cartridge case and a return to the old-fashioned cartridge bag result not only in a considerable saving in weight and cost of ammunition, but also in an actual gain in rapidity of fire. Quick working breech mechanisms, however, which until recently could only be used with metallic case ammunition, are being constantly improved and further extended in use, and the name rapid fire gun has now come to designate any gun whose breech is opened and closed by a single sweep of the hand. In this sense our new 7-inch gun will be a "R. F." gun, but it would be better to call it a "quick fire" gun and to limit the name "rapid fire" to such guns as use metal cases.

Another improvement which helps us to suppress cartridge cases without loss off efficiency is a firing mechanism which allows priming with the breech open without danger of a premature explosion, and which automatically ejects the fired primer as the breech is opened.

I have just spoken of our new 7-inch gun as being a quick firing gun, as having a breech mechanism actuated by a single motion lever. This has been rendered practicable primarily by an improved gas check, but secondarily by the use of screw breech plugs having more than half their surface threaded. This improvement has been applied to all our guns from the 4-inch up, though it has greater and greater advantages as the calibre increases. Thus it enables the length of screw box and plug of the 12-inch gun to be reduced some 6 inches, which means, first, a saving in the weight and cost of gun; second, a lighter and more easily manipulated breech block; third, a more direct lead of the ammunition hoist from loading room to breech and less space to load through; and fourth, a less diameter of turret with saving of weight and cost of armor.

With the 6-inch R. F. gun it takes less than two seconds to

open and again close the breech, and a well-drilled crew can load in from 5 to 6 seconds, so that the "loading interval" is from 7 to 8 seconds, and, starting loaded, from 8 to 9 unaimed rounds can be fired in one minute.

The old 8-inch breech mechanism took about 10 seconds to open and close; with the new high-powered 8-inch gun this time will be reduced to about 5 seconds, and as the shell and charge can be inserted in 10 or 11 seconds, and the gun is primed during this operation, the loading interval will be about 15 seconds, and, starting with the gun loaded, it will be possible to fire 5 unaimed rounds in one minute.

These are the results of experiment on the proving ground, and there is no reason why they should not be equaled on board ship, excepting in so far as there is lack of space for rapid work in some of the 8-inch turrets.

With the larger calibres, new conditions come into play, and greatly increase the loading interval. Not only will weight of breech block and lack of space in turrets probably always prevent the use of a hand-worked single-motion breech mechanism on a 10-inch or 12-inch gun, but the necessity of using a mechanical rammer to push home their heavy projectiles, and the division of their powder charges into two sections, which have to be successively loaded, must always result in a marked distinction between their rate of fire and that of smaller guns. Improvements in ammunition hoists and in rammers have done much to reduce the time required to load the heavy turret guns, but still more can be accomplished by intelligent zeal on the part of those who actually handle the gun on shipboard. Thus, for example, the late Lieutenant Haesler materially reduced the loading interval of the Amphitrite's 10-inch guns by the simple expedient of having the two sections of the powder charge removed from the hoist while the shell was being rammed home, and loaded by hand the instant the rammer was withdrawn. Undoubtedly, the loading interval of heavy turret guns, even more than that of small guns, depends very greatly upon the skill with which their loading appliances are handled, and can only be reduced to a minimum by constant practice.

It takes about 9 seconds to open and close the breech of the new 12-inch gun fitted with our hand worked mechanism, which is, in my opinion, the most efficient one in existence, and to re-

duce this to the time required with a rapid-fire gun, we must resort to the automatic operation of the breech mechanism, which, moreover, besides reducing the loading interval by some 7 seconds, will reduce the number of men required for working the gun and will furnish a perfect protection against the danger of a hang fire, since the breech cannot open until the powder charge has exploded and caused the gun to recoil.

Coming now finally to the "pointing interval," which with the "loading interval" makes up the time from fire to fire under service conditions,—this has evidently been greatly reduced on the average by the use of smokeless powder, but is still a very variable quantity, depending not only upon the skill of the gun pointer and the efficiency of the pointing mechanism, but also upon the state of the sea and other changing conditions. In so far, however, as the pointing intervals of guns have been reduced in recent years by mechanical improvements, it is by improved gun mountings that the saving of time has been effected, and, as far as heavy gun mountings are concerned, the successful use of electricity for manipulating them has been the chief cause of the saving of time. Steam, and especially hydraulic machinery, for working heavy gun turrets, will not give the smooth, steady, and perfectly controllable motion so necessary for pointing at a moving target, but electric motors do. As far as the mounts of rapid-fire guns are concerned, the ease and rapidity of motion which can be attained when they are handled by practiced men leave little to be desired.

The ideal gun mounting would be one with which the line of sight of the gun could be kept constantly upon the target, regardless of the motion of target and of gun itself, and with such a mounting the pointing interval would disappear and the rate of aimed fire equal that of unaimed fire. We are, of course, far from attaining this state of perfection but we are gradually approaching it. Even to-day it depends wholly upon the skill of the gun pointer, only to be acquired by practice, whether the rate of well-aimed fire of any gun shall be a maximum or shall be only a small fraction of what it should be.*

* *Note by the author.*—The major part of this essay, including this paragraph, was written more than two years ago, at which time certainly no one in our Navy, and probably no one in the world, knew that what is now called "continuous aiming" is practicable with naval guns.

The enormously greater destructive power of modern projectiles than those used 50 years ago results from these two things,—1st, hollow shells filled with explosives have replaced solid shot, and 2d, the rifle principle enables us to use elongated projectiles, weighing four times as much as the old spherical ones, and which, traveling point first, can readily be caused to explode by impact. One of the most important and pressing ordnance questions of to-day is to determine the character and arrangement of explosive charges which will make shell most destructive. We use fine-grain black powder for our bursting charges; should we replace it by a high explosive?

Merely stating that in my opinion the so-called "torpedo shell," designed to throw great quantities of high explosives, has necessary disadvantages which outweigh its possible advantages as a projectile for naval use, I shall only consider such projectiles as are suited to be fired with high velocities from the latest type of naval guns. Such projectiles may be roughly divided into the two classes of "thick walled" and "thin walled" shell, according as they are or are not designed to have any armor-piercing qualities.

Considering first "thin walled shell;" these can carry, as a maximum, bursting charges of black powder weighing about ten per cent of their total weight. For these charges can be substituted a somewhat greater weight of a high explosive,—gun cotton, picric acid, lyddite, melinite, or what not,—but to get good explosive effect, each of these compounds must have a fulminate detonator associated with it. If strongly confined and merely ignited by an ordinary percussion fuse, they produce a violent explosion, but the confinement in thin walled shell is insufficient for this as a rule. The lyddite shell used in the Soudan and South Africa were fitted in this way, and such a large percentage of them failed to burst, merely breaking open, and the greater part of the contents remaining unexploded, that they were considered a total failure and looked upon rather with contempt by those against whom they were directed. If, on the other hand, such shell are fitted with fulminate detonators, their explosion produces much more complete fragmentation and a much wider cone of dispersion than does a gunpowder shell. It must not be supposed that the shock of the explosion counts for anything in the damage done. Outside of the poison-

ous effects of the gases and the direct action of the flame, it is the projected fragments which cause what destruction there is. A powder bursting charge will break a thin-walled shell up sufficiently, but the fragments do not spread much. The detonation of a high explosive charge produces a much wider cone of dispersion, and therein lies its greater destructive effect. Moreover, the action of the detonated shell is much quicker than that of the one burst by ignited powder,—the former bursts almost at the point of entrance and its fragments are sometimes driven through the deck above or below it,—the latter ranges from 10 to 20 feet before it bursts, and its fragments continue on in a cone of not very great angle. On the other hand, the high explosive shell is more likely than the powder shell to explode harmlessly outside,—either of them is completely ineffective if its impact is against even the thinnest armor, but the former is liable to burst before it gets through skin plating which it strikes at an angle. Finally, the detonating shell is vastly more dangerous to use than the powder shell,—premature explosions of each will sometimes occur; and while the worst effect of the latter is then to mar the gun, that of the former may be to burst it with demoralizing results.

But now, having weighed the relative advantages and disadvantages of thin-walled detonating shell as compared with the same shell loaded with powder, and supposing that we decide for the former, we have still to consider this question,—Is it desirable to have a class of projectile which is only effective against the entirely unarmored parts of ships,—is it not better to sacrifice explosive effect in all shell to gain power of penetration? All armored ships of recent construction have their vulnerable parts covered at least with thin armor; modern practice tends more and more to distribute, not to concentrate, armor.

Certainly it seems to me that the guns of armored ships, whose prime function is the attack of other armored ships, would much better use only thick-walled shell than attempt to produce greater destructive effect by hits upon unarmored parts.

As for the guns which form the main batteries of unarmored ships, since these cannot be expected to be opposed to armor, it may well be that their effectiveness would be increased by the use of thin-walled detonating shell, and the question, whether or not the attendant dangers should be accepted, needs careful

consideration. One thing, however, we may feel sure of, and that is that there is no such vast and overwhelming superiority of the high explosive over the powder shell as is popularly supposed to exist.

Considering next "thick-walled shell," and including under this title both regular armor piercing shell and what are known as semi-armor piercing shell, let me first point out the fallacy of the idea that any sort of delay-action fuse is necessary to enable such shell to carry bursting charges through armor. If the charge is of a nature not to detonate on impact, as gunpowder, picric acid, wet guncotton, melinite, or lyddite, but is ignited by the shock of impact, it takes enough time for it to get up pressure to burst a thick-walled shell to enable that shell to perforate all the armor it is capable of perforating before the burst takes place. We know that a heavy shell fired through structural steel plating ranges some 20 feet before it bursts from the action of a percussion fuse and a black powder charge. This means a time interval from impact to burst of say $\frac{1}{100}$ of a second. Now suppose a 12-inch shell, strong enough to go through unbroken and without serious distortion, to strike a 12-inch plate with 2,000 f. s. velocity, and to just get through it. Its mean velocity would be about 1,000 f. s., and so it would take it only $\frac{1}{1000}$ of a second to perforate the plate. Actually it would have some remaining velocity, and so the interval would be less, but the rough comparison is enough to show that the time to burst is much longer than the time to perforate. It is only when the shell is either broken or much upset by impact with the armor that its explosive charge cannot be carried through and exploded behind the armor. This was demonstrated at our Proving Ground years ago with black powder by firing fused 6 pdr. a. p. shell through 3-inch steel plates, when they burst after just perforating the plates, and by firing a 10-inch semi a. p. shell, loaded with 20 odd pounds of black powder, and fused, through a 7-inch hard faced plate when it burst several feet beyond the plate. It was also proved with jovite, a picric acid compound, just as are melinite and lyddite, by firing a 10-inch a. p. shell, filled with that explosive and with an ordinary percussion fuse, through a 14-inch hard faced plate, and bursting it behind the plate.

We do not, as yet, load our a. p. shell, but there is no difficulty

in the way of doing so. Black powder will not always burst such shell, and so it may be better to load them with picric acid, jovite, a fine-grained smokeless powder, or some other substance which, when ignited with an ordinary percussion fuse, and being strongly confined, will not detonate, but explode. The certainty of the shell, if it gets through armor, being broken into pieces, and not remaining whole, would be worth a good deal even if the explosion itself were of little violence.

Under these circumstances, then, the problem as regards thick-walled shells resolves itself into this,—shall we be content with a moderately powerful explosion of each shell behind armor or anything else they can perforate, or shall we attempt to make them detonate? If the latter, there must not only be a fulminate detonator in each shell, but also some sort of a delay action for that detonator, since otherwise the detonating action, being vastly more rapid than that of explosion by simple ignition, would cause the shell to burst harmlessly outside of any armor it might strike. All this I believe to be perfectly practicable, and again it is merely a question of expediency. We must weigh the relative advantages and disadvantages and decide whether or not the somewhat greater destructive effect of the detonating shell is worth attaining at the expense of its greater complications and its greater danger to ourselves. The Ordnance Department of the army have decided in favor of high explosive shell charges upon grounds which do not altogether apply to the navy. With their use of high angle fire from shore batteries, the sphere of action of the high explosive shell of large capacity is considerably increased by the torpedo effect of an underwater burst,—with the flat trajectories needed in naval actions such an effect cannot be expected.

There was considerable complaint made of the inefficiency of our common shell, as instanced by many failures to burst observed in the bombardments at Santiago. These failures were due to the fact that our base percussion fuse was developed by experimental firings through thin steel plates, such as form the skin plating of ships, and, while sufficiently sensitive to be exploded by the impact of the shell upon such plates, was not sensitive enough to explode when the shell struck comparatively soft earth. This experience has led to the substitution of a much more sensitive percussion cap for the one formerly used in

fuses; but that our shell, even before this change, were effective when used against ships, the results of the battle of Manila Bay and Santiago sufficiently testify.

The following description of the effects of 12-inch common shell which entered the Reina Mercedes when the Spaniards were trying to sink her in the channel of Santiago on the night of July 6, 1898, will give an idea of what destruction such a shell may cause. It entered the port quarter, burst 18 feet inside, and after ranging 120 feet, the central fragments passed out through the starboard bow. A hole 6 x 3 feet was blown down through the main deck and a number of fragments entered the engine room, where they cut several steam pipes and ripped the lagging completely off the top of a boiler. A machine shop and dynamo room built around the main mast was completely demolished, everything in it being destroyed, and the mast itself was cut in two by a fragment and dropped vertically 4 inches, slacking up all the rigging. A number of large holes were cut through a bulkhead surrounding the smokestack and uptake and they were pierced with many holes, both safety valves being knocked off and two steam pipes cut. On both sides, on the decks above and below, and in beams and stanchions, were numerous cuts and dents showing where fragments had struck, and it may fairly be said that one such shell, in actual battle, would have swept the deck clear of men and practically put the ship out of action.

The effects of gun fire, however, depend not only upon the action of the shell which has reached its mark, but upon the power which enables it to get to its mark, upon the number of shell fired, and upon the percentage of hits. We have seen that the great mechanical improvements in ordnance material in recent years have tended largely to increased rapidity of fire, and that the use of smokeless powder has not only greatly increased the penetrative power of projectiles, but also enables us to attain under service conditions a rate of fire approaching that obtained on the proving ground. But it is in the small percentage of hits that naval gun fire falls short; destructive power there is and rapidity of fire, but accuracy of fire is still greatly lacking. At the battle of the Yaloo the Chinese battleships fired 197 12-inch shell and but 7 of them hit Japanese ships, and lest we attribute this to special inefficiency, let us remember that our own per-

centage of hits at Santiago was only about 4. Now it is not the gun which is here at fault. With the distance known, a modern gun fired from a stationary platform will put every shot in a 10-foot square target at 2,000 yards. The trouble is three-fold. Supposing the sea to be perfectly smooth, there are two important causes of error, the first due to incorrect estimation of the distance of the target, and the second due to imperfections in the sighting mechanism.

No satisfactory range-finder has yet been introduced into our naval service, and though the flat trajectories which result from the high velocities given by the latest type guns reduce the errors of gun fire due to lack of correct knowledge of distance, yet these errors are still large. In the second place, there is a considerable error in pointing guns caused by the inability of the eye to determine with certainty when the rear sight, the front sight and the distant object are in line; consequently, when the gun pointer fires, thinking his gun is correctly pointed, he is usually considerably in error. The telescope sight largely removes this difficulty. But even if we had perfect range-finders and perfect sighting apparatus, the greatest cause of error would still remain. The pitch and roll of the ships, due to the never-ceasing motion of the sea, disturbs the line of fire during the interval between the gun pointers willing to fire and the actual departure of the projectile from the muzzle. Not only is there a perceptible time between the pressing of the electric key which fires the primer and the exit of the projectile from the gun, but there is much greater interval between the time when the gun pointer wills to press the key and the time when he actually does so. This latter interval, called the personal equation of the gun pointer, is said to be $\frac{3}{10}$ of a second on the average, and during this period the roll of the ship causes a considerable change in the elevation of the gun and thus causes a projectile which would otherwise hit the target to pass far above or below it.* The marksman's skill lies principally in making proper allowance for his personal error, but, under the constantly varying rate of

*Note by the author.—The practice of the method of "continuous aiming," which has been demonstrated to be practicable by Captain Scott, R. N., and to which the attention of our service has been called by the zealous efforts of Lieutenant W. S. Sims, U. S. N., will largely reduce, if it does not wholly destroy, this error.

angular motion, this can never be done with any great accuracy, and thus under ordinary conditions of gun practice at sea the percentage of hits is always very small.

Further increase in the destructive effects of naval gun fire must come rather from increased skill of the gun pointers than from any improvements either in guns or in their projectiles.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

ON NAVAL OPERATIONS OF THE CRIMEAN WAR.

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The war in the Crimea, with the Russians on one side arrayed against the allied forces of England, France, Turkey and Sardinia, on the other, coming as it did after a long period of European peace, induced many brilliant writers of the different nationalities to devote their best talents to a description of the thrilling events with which it was so uniquely replete. The terrible sufferings endured by the combatants; the brilliant achievements of the besiegers and the besieged, and the final catastrophe have been celebrated for many years in prose and song. Military and engineering experts have given the features interesting to students of their sciences the deepest study, and the English Parliament itself took part in one controversy at least growing out of a military question, but in a careful study of all the authorities available, I have thought to find a seeming want of appreciation of the extremely interesting and influential part taken by the naval forces engaged, which is without doubt due to the almost total lack of picturesque sea combats, and the absorbing pre-eminence of the magnificent combats on shore.

The writer has derived a keen enjoyment from the study of the various authorities consulted, in collecting and arranging the naval events of the war together with their bearing and influence upon its course,—he has further thought to discover that, as in the case of our own civil war, the influence of the navy has been considerably underrated and that lessons of the greatest importance concerning the use and abuse of sea power, more especially in its intimate relation to coast warfare and combined operations, lie not far from the surface of nearly all the operations of that war.

This war possesses a further interest for the casual reader in that fact that breaking, as it did, the thirty years' peace of Europe, it was inevitable that great changes should be exhibited in the material of war, if not in the methods of warfare. The development of armor dates from that war; the rifled musket also which in one action at least turned the tide of battle; horizontal shell fire, though not used for the first time, established itself for all time during that war, and for the first time were the full capabilities of insignificant earthworks demonstrated, when their defense was directed by a genius. The lesson of high command for coast batteries, elicited long before, was sealed by the naval assault on the works of Sevastopol; the first monitor, or the English idea of that famous vessel, received its baptism in the Sea of Azov, and the extreme usefulness of vertical fire from large mortars in sunken batteries was urged immediately at the close of that war.

For the purposes of this article it is necessary only to refer casually to the events preceding and leading up to the allied descent upon the Russian peninsula in the Black Sea.

On the 30th of November, six Russian ships of the line under the command of Admiral Nachimoff attacked and destroyed a Turkish squadron lying at anchor in Sinope. The Turkish squadron consisted of six frigates, one sloop, one steamer and some transports, and was but poorly supported by the weak shore batteries. The Turks commenced the firing, and all the Turkish vessels were destroyed with the exception of the steamer, four thousand men being killed, and it is said that all of the four hundred survivors were wounded. The action was totally unequal, and has no interest in itself except as regards the profound impression created which made peace impossible, but as a strategic move it was certainly brilliant on the part of the Russians, except in so far as the destruction of the Turkish vessels is concerned, for if captured undestroyed they would have considerably augmented the Russian forces, and later might have turned a balance of vital importance to the Czar.

The circumstances immediately preceding this event, involving the relative strategic direction of the Russian and the allied squadrons, are interesting, and at the same time render it more difficult to understand the subsequent action of the Russian leaders in regard to their fleet. It will be remembered that the

allied squadrons had entered the Bosporus on the 22d of October. The English Ambassador in Constantinople, Lord Stratford, had been informed by his government that "if the Russian fleet were to come out of Sevastopol, the allied fleets would then, as a matter of course, pass through the Bosporus." This meant nothing more nor less under the circumstances than that the leaving of Sevastopol by that Russian fleet became sufficient ground for naval hostilities. Now, the Russians made no secret of their naval preparations; the Czar intended that his navy should bear a prominent part in the defense of his empire, and the allies had full knowledge of the great and hurried preparations making in Sevastopol. No attempt, however, appears to have been made to observe the fleet in that port, and, indeed, until the actual sailing of the fleet such action might have been premature; but, when the Black Sea fleet came out in November and stretched across the Black Sea between the Crimea and the ports on the south shore, it certainly had become time to act.

On the 20th of November a Turkish steamer was captured, merchantmen were openly boarded by the Russians, and a cruising squadron of eight vessels masked the three ports of Sinope, Bartin and Amasbre. This was reported at once to Constantinople by the Turkish commander in Sinope, the news reaching Lord Stratford not later than the 26th, four days before Sinope, and apparently nothing was done, no observation vessels were sent out to procure precise information, no single effort was made to avert the impending catastrophe. France and England together had guaranteed to defend "Constantinople, or any other part of the Turkish territory, whether in Europe or in Asia, that might be in danger of attack." Yet the Turkish commander pleaded for help in vain—with the Russian fleet in front of Sinope, no attempt whatever appears to have been made to gain any information of its intentions,—if the Russians acted with judgment and quickly in destroying a hostile detachment, how can the conduct of the allies be characterized?

The largest guns in the Turkish fleet at Sinope were 24-pounder solid shot guns, while the batteries on shore had little armament and the defenses were otherwise weak. The Russians were provided with the Paixhans shell guns, using time fuzes, which were first experimented with at Brest in the years 1821-24, but their destructive effect in war was first entirely demonstrated

at Sinope, and at that time the war performance of shell with percussion or concussion fuzes was not known.

It may be of interest to quote from a letter written by General Paixhans, published in 1854, in which he outlines his conception for a naval policy which should follow upon the proper utilization of his weapons. He says: "Without entering into details, I shall add, that, in considering the different maritime and commercial conditions of other nations, it will be perceived that the mode of warfare best adapted to our country should rather be a system of desultory and unexpected expeditions and offensive cruises, than the heavy and disastrous system of regular battles and general actions. A hundred powerful and rapid frigates will evidently be more useful to France than forty or fifty ships of the line; and this change of system is supported by two authorities of great weight—that of the Emperor Napoleon I, towards the end of his career, and the decisive facts of our recent history. Other powers may indeed adopt the same change, but, if it were not to give this notice too wide a circulation, it would not be difficult to demonstrate that, if a general abandonment of the expensive system of fleets were to take place, France would have little to lose and much to gain."

It is curious in this passage to observe the resemblance in the effect produced in the general's mind by his great invention, and that produced in the minds of Admiral Aube and Gabriel Charmes and their followers a few years since when contemplating the torpedo and the swift cruiser. So far as the authority of Napoleon I is concerned, we know that he adopted eventually the only system that he was permitted to adopt by the English fleets.

Politically, but under pressure of public sentiment, this event of Sinope roused the English, and through a taunt addressed by the Czar to Napoleon III, the French were equally aroused. The allies, French and English, in February, 1854, demanded the evacuation of the Danubian Principalities by the 30th of April, and lacking an answer, war was declared in March. The allied troops were landed at Varna to defend the land fortresses on and south of the Danube, and Austria, backed diplomatically by Prussia, moved 50,000 men down the north bank of the Danube and demanded the evacuation of the territory occupied by Russia. In August the Russians abandoned the provinces and

Inkerman Valley
Inkerman R.
Little Redan
Great Redan
Flagstaff Bastion
Alexander Fort
Constantine Fort
St Michael Fort
Telegraph Battery
Quarantine Sea Port
N

Austria occupied them. This might have been the end, but it seems that Sinope had been too much for England, and both England and France hesitated to withdraw without accomplishing anything further, having previously entertained the project of attacking Sevastopol.

The objects to be gained by that attack as stated by various high authorities were the destruction of the Russian fleet in the Black Sea, and the prostration of the fortifications defending that sea, and, again, that a blow must be struck at the very heart of the Russian power in the East. The difficulties inherent to these operations were clearly foreseen in London, though no idea existed as to the immense cost in treasure and life which was ultimately involved, before the objects stated were fully accomplished, if they were ever fully accomplished. The English Minister of War, writing subsequent to the withdrawal of the Russians from the Danube, says: "The difficulties of the siege of Sevastopol appear to Her Majesty's government to be more likely to increase than diminish by delay, and there is no prospect of a safe and honorable peace until the fortress is reduced, and the fleet taken or destroyed, it is on all accounts more important that nothing but insuperable impediments such as the want of ample preparations by either army or the possession by Russia of a force in the Crimea greatly outnumbering that which can be brought against it should be allowed to prevent the early decision to undertake these operations. It is probable that a large part of the Russian Army now retreating from the Turkish territory may be turned into the Crimea to re-enforce Sevastopol. If orders to this effect have not already been given, it is further probable that such a measure would be adopted as soon as it is known that the allied armies are in motion to commence active hostilities. As all communications by sea are now in the hands of the allied powers, it becomes of importance to endeavor to cut off all communication by land between the Crimea and the other parts of the Russian dominions." Sir Edward Hamley says, besides expressing his opinion that the Crimea was the most vulnerable part of the Russian Empire, that "it is certain that even a probability that it (a siege of Sevastopol) would last through the winter would have put an end to the project."

The war after the expulsion of the Russians from the Danube,

became one purely offensive on the part of the allies, and after the conclusion of the tremendous struggle, its traces were quickly removed, the culmination taking place in the repudiation of the Black Sea clause of the Treaty of Paris when that city fell in 1871.

There are lessons to be drawn from that war which England will probably remember in case she should again be involved in war with Russia; circumstances since then having changed and somewhat in favor of Russia. An invasion of Russia by the Baltic or Black sea is probably somewhat less certain of results and it is not likely that a much greater number of troops or munitions could be transported to either sea; while in another war France would probably not find her interests identical with those of England. An overwhelming number of Russians could be beforehand at any point threatened through the judicious development of the interior communications. The stress of the war in the Crimea hardly affected the Russian Standard of gold at that time and her power to make counter strokes coincident with her advance in Asia has vastly increased, while operations in either sea other than the blockade of both would without doubt be confined to what could be accomplished quickly by vessels alone, after the question of fleets had been disposed of.*

There may be a peculiar interest attached to the operations of this war apart from their mere consideration as such, in a similitude of the scene of the war in its geography, the relative forces employed, both naval and military, its relation to the home bases, and lines of communication with what a war in the penin-

* It is interesting to note the means by which Russia in so short a time has been enabled to put afloat her formidable Black Sea fleet, which has all been done in the years since 1881. A clause of the treaty of Paris forbade to either country, Russia or Turkey, the establishment or maintenance of any military maritime arsenal on the coasts of the Black Sea. On the part of Russia this clause was diplomatically evaded by maintaining an arsenal at Nicolaev, 30 miles inland on the river Bug, ready for work when it was wanted. Soon after the Crimean war the "Russian Steamship and Trading Company" was formed to develop the commerce of the Black Sea. The company's headquarters were at Odessa, and the site of the dock yards at Sevastopol was acquired by the company for the repair of its ships, and eventually built upon to provide for the construction and docking of vessels. This company was favored by government subsidies and protection and

sula of Nova Scotia might be. In Nova Scotia I think it will be conceded that an important objective might be found—certainly one most valuable to England for many reasons, at the same time, without the command of the sea, a most difficult if not impossible one of accomplishment. The physical resemblance will be readily granted,—the peculiar shaped peninsula, almost an island with navigable waters on all sides, the climate, the proximity of great rivers, the long thin lines of communications, the indentations, and the great war harbor.

In discussing strategic questions, English writers are wont in referring to the possibilities of war with the United States to deprecate any discussion. This is easy for them, for in settling their position and policy with reference to nearer and more probable enemies, the case of war with us is provided for perhaps. For us, however, with England our only neighbor with coterminous territory to be seriously regarded at present, if we do not frankly consider the possibility, what possibility are we to consider?

The fact that Nova Scotia is a coal mine for the English fleets on this side of the Atlantic, while Vancouver is a good first or second on the Pacific, would make the loss of either or their investment a matter of great concern. The operations of the allied fleets in the Crimea may have a very useful lesson for us thus considered, and at any rate there will be apparent the proper and improper directions given to sea force by both sides, and the intimate relation which should exist between a fleet and an army, each performing its part in the strategic game. It

enjoyed a practical monopoly. It rapidly gained wealth and power, and it has been surmised, I believe, that royalty did not view its material advance with disfavor. In 1883 this company was enabled to take the contract for the construction of the "Tchesme and Sinope," and three large cruisers, and the contract for building the George the Victorious, and later many others. Naturally the government coveted this yard and the exchange was made amicably and to the profit and pleasure of both parties in 1891, the peaceful company establishing itself in Odessa. Great as are the facilities at Nicolaev, the difficulty of keeping the water deep enough near Kinburn Spit, and the winter ice, will probably add to the importance of Sevastopol. Nicolaev on account of its greater defensibility will undoubtedly be maintained, however, and the largest vessels can be built there.

may be apparent further that tremendous as is the factor "command of the sea" in warfare, that it is not everything in certain classes of operations, though vitally necessary; and that from the magnitude of operations, other than naval, peace may be forced in face of that command of the sea—this fact lying on the face of all history, and when borne in mind the error will be avoided of unduly appreciating that command.

The allies, English, French and Turkish, held the undisputed command of the sea owing to the inaction of the Russian fleet, and the Crimean war was also waged practically between two contiguous countries, Russia and Turkey, with a sea line or front common to both. The English and French fleets and forces, though originally from a distance, by reason of their bases strung along their routes from their own countries and the alliance with the Turks, found their main base securely established in Turkey. In these respects the operations of the war were vastly simpler than any that might be undertaken over a wide expanse of ocean with no bases near the coast attacked, and also in these respects a similarity exists in our own case in the civil war, considered in relation to the command of the sea, and the geographical relations of the territory involved. It may be also that besides England's position to-day, that of France in regard to our own has a certain similarity in the same respects, though the command of the seas in these days may not be so absolutely admitted. While it was urged upon the allies that the stroke should fall quickly, it happened that such could not be the case; delays were experienced from one reason and another, of which the outbreak of cholera was the most disastrous and far-reaching. The embarkation which took place at Varna was one of great difficulty, but finally the expedition was united in the bay of Balchick, the rendezvous.

The military situation was then about as follows. The Russian fleet in Sevastopol comprised fifteen sailing line-of-battle ships, seven frigates, two brigs, one corvette; the Vladimir (a powerful steamer) and eleven lighter class steamers, mounting 1908 guns and manned by 18,500 seamen. The united number of allied transports was 600, the covering fleet carrying 3000 pieces of artillery. The sailing vessels were towed by steamers; coaling ships accompanied the expedition, and boats especially constructed were carried alongside the transports to facilitate the

landing, while an English force of ten line-of-battle ships, including two powerful screw steamers; two fifty-gun frigates, and thirteen heavily armed, though smaller steamers, were held free from transport duty to cover the remainder of the expedition, while many heavy guns were transported on platforms laid upon two boats.

Of the remaining war vessels, the French had fifteen line-of-battle ships, and ten or twelve steamers of good size; the Turks, eight line-of-battle ships and three steamers, but all encumbered as transports, while the military force embarked for the expedition amounted to 61,000 infantry, 1000 cavalry and 128 guns.* The Russian forces in the Crimea engaged in the first battle consisted of about 33,000 infantry, 3400 cavalry and 120 guns, while the total force in the Crimea reaching nearly 60,000 men, re-enforcements being hastened forward from the Empire and from the Danube.

The expedition sailed on the 7th of September from a rendezvous "forty miles west of Cape Tarkan" and but eighty miles or so from Sevastopol, where the leading ships anchored on the 9th. From there the coast was reconnoitred by steamers from Eupatoria to Balaklava, Old Fort on Kalamita Bay being finally selected for the landing place, through considerations which must always obtain in such selections; proper water near the beach, room for the troops after landing in order to take position and deploy rapidly and of such a character as to enable the ships to cover the landing by their fire. The landing occupied four days from the beginning until the time when the troops were ready to advance, bad weather prevailing during part of the time occupied in landing having delayed that operation unduly. I have nowhere seen any reasons given why the Russians should not have fallen upon the detachments already on shore during the nights, but the war shows many seeming examples of lost opportunities.†

From the time of anchoring off Cape Tarkan to the time when the landing was completed was nine days, during five of which the allied expedition was not at all united, in fact it was not all

*The total population of the Crimea was but 200,000 people.

†30,000 men and 24 guns only were landed between 7 a. m. and 6 p. m. of the first day, and at nightfall the landing was suspended by the heavy surf, the weather being so bad that many of the boats were swamped.

united until the landing was completed on the 18th. No efforts were made by the allies to blockade the Russian fleet in Sevastopol, and but few if any efforts were made to observe that fleet. The fleet was the equal if not the superior to the only force held ready by the allies to oppose and attack it, and certainly the expedition itself was in disorder. It is imputed to the Russians, and with good reason, that a great opportunity was lost, the Russian admirals begging to be allowed to attack the allies, but meeting only refusal. They were told that the men and guns were needed for defenses on shore, and their services there make some of the bright pages of the siege, the vessels themselves after their sacrifice at the entrance to Sevastopol playing a useful though an ignoble part.

If this action in regard to the fleet be contrasted with others, de Ruyter's in the Schoneveldt, for instance, and the opportunity considered—the clumsy allied flotilla spread over many miles, but a few hours in time from Sevastopol—it becomes more difficult to understand the inaction of the Russian fleet, nor is it easy to comprehend the action of the allied fleets under such a menace. Nothing but confidence in their ability to deal with the Russian squadron on any terms or a knowledge that it would not attack, can explain the leaders' loose way of protecting the expedition en route.

It is a matter of fact that the chief anxiety of the commanders-in-chief of the expedition was due to an expected attack on the part of the Russian vessels, and yet what were the means concerted to meet it? The simple telling off of a portion of the armed force of about equal strength with the Russian squadron, leaving it unencumbered with troops and their holding it on the flank of the transport flotilla, but with one vessel detailed for duty in front of Sevastopol. The naval conduct of the war has been criticised by able English officers since, so it is not unbecoming for any one to express surprise that well-known simple strategic principles were so utterly neglected. What reason existed why that covering squadron should not have been placed where the observing vessel was, in front of Sevastopol? Then the landing could have gone forward in absolute security, there being no fear in the expedition that the landing would be opposed on the beach and the only threat which could have been offered seems to have been left unnoticed.

Prince Menschikoff was High Admiral of the Russian fleet, and in his absence Korniloff, the Chief-of-staff, was in command. The approach of the allied fleet was signalled to Sevastopol, and orders were at once given for the sailing of the Black Sea fleet, but the first day the wind was northwest in the offing. In the evening the fact was signalled that the allied fleet was coming to anchor, the Russians pleasing themselves by recalling that the date, the 14th of September, was the anniversary of Napoleon's entry into Moscow, but the weather was now calm, and Kinglake says: "also the general desire to attack the allies while landing was not now so great." After the battle of the Alma on the 21st of September, Korniloff called a naval council, and addressing the council said, amongst other things: "I therefore propose to put to sea and attack the enemy, crowded as he is off Cape Lukul. I think that, fortune favoring us, we might disperse the enemy's armada, and thus deprive the allied armies of supplies and re-enforcements. In the event of failure, we shall be able to avoid a disgraceful capture; for, supposing that we do not succeed in boarding the enemy's ships, we can at all events blow them up when they close alongside, together with our own. While thus saving the honor of the Russian flag, the seamen will be defending their port; for the allied fleets, even if victorious, would be so weakened by the loss of many ships, that they would not dare to attack the strong sea batteries of Sevastopol; and without the co-operation of the fleet, the allied armies could not capture the town, if fortified and defended by our troops, until the arrival of a fresh army from Russia, and then, with the united exertions we might crush the enemy. The absence of all order in the disposition of the enemy's fleet during the landing and off Cape Lukul, the carelessness of their cruisers, which have not yet captured even one of our steamers on the Black Sea during the whole summer, the carelessness of the allied admirals, who have allowed our squadrons to cruise freely in sight of Sevastopol . . . . who have even allowed the steamer Tamar to leave Sevastopol, and to cruise, caring little for the countless steamers of the enemy, on the lines by which the allies communicate with the Turkish ports, all this plainly proves that against such an enemy success is not impossible." Korniloff's picture of the condition of the allied fleets was not entirely a true one, and the time had gone by perhaps for the rally which should

have been made near the 14th, yet he went to Menschikoff and announced that he was going to sea, with the result that he was forbidden to do so under threat of being displaced.

After the landing the advance of the allies southward was made along the coast with the right flank resting on the sea, covered by the fleet. A slight skirmish took place at the river Bulganak, but the army pushing on reached the river Alma, where the battle of the same name was fought. The vessels do not seem to have played much of a part in this battle, although some French ships threw a few shell over the plateau occupied by the Russian left on the south bank of the river. The only point to notice in connection with this battle, or rather the advance to the Alma, as bearing upon the subject, is the opinion expressed by Sir Edward Hamley that "the Russians by attacking in force on the allies' left, away from the sea might have decisively embarrassed the advance of the allies, unless a crushing defeat could have been inflicted upon them, although by having command of the sea, thanks to the supineness of the Russian fleet, the allies could have fallen back upon their ships." But if they had so fallen back upon their ships, what a great advantage the Russians would have reaped in harassing them in retreat and in the time gained—second only to the effect upon the undertaking of a desperate attack upon the expedition afloat, in the first instance, and whilst re-embarking in the second.

There is a curious coincidence and sameness in the records of most invasions in the manner in which the invaders make good their foothold by winning the first battle, it usually being brought on by the native armies before they are prepared to ensure success. If the allies had been driven to their ships from the Alma, by the time they could have prepared for another attempt if they had desired to make it, the Crimea would have been in a far better state to repel the invasion.

Following the battle of the Alma the allies proceeded to the north side of the harbor of Sevastopol at the Belbek. Whether to establish the army on the north side and on the road to Bakchi Serai, the main line of the Russian communications, or to proceed to the south was a question that at the time was carefully considered. Arguments were strong on either side, and since the war it has been and is still a disputed point upon which the authorities widely differ. The operation of proceeding

down the coast direct to the north side with the right resting on the fleet and, in a combined engagement with the land and sea forces, the occupation of that side and the turning of its guns on the south, is one that seemed very attractive and especially commends itself to naval people. Concerning this question, an authority before quoted says in effect, that this was manifestly not only a quite desperate but a fruitless enterprise, except .... the fleet should take a principal part in the attack, meaning that some of the ships should have passed in and attacked the vessels in the harbor, while others engaged the forts, the army holding itself in readiness to descend from the heights. In Sir E. Hamley's language: "Sevastopol might have fallen in a storm of battle as tremendous as the world has ever witnessed."

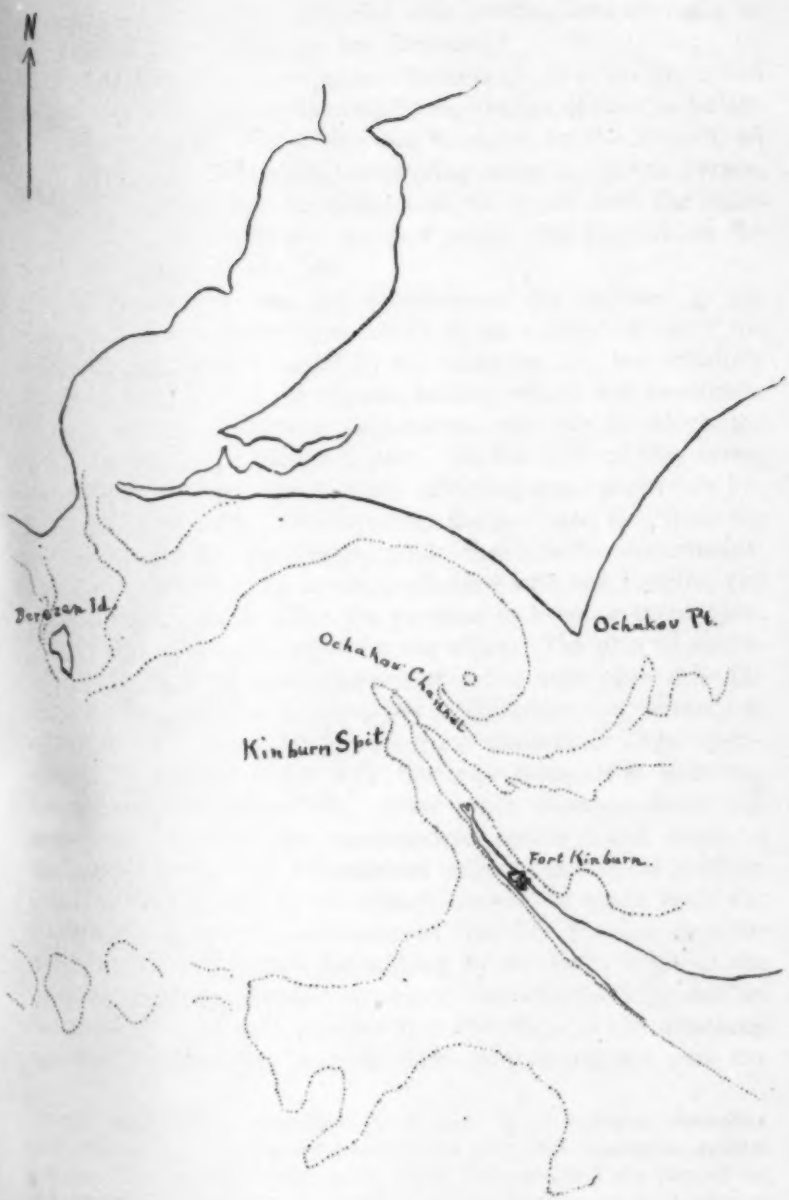
Delays before the question was settled enabled Todleben to strengthen his positions, twelve of the forty-seven guns in the Star fort bearing upon the approaches from the north. The fort itself was a land defense covering the forts in the harbor, being in turn looked into from the heights still further north. Nine more guns were mounted in batteries, some of them covering the approach by the coast, and finally Todleben got twenty-nine guns available from the northern defense. The allies might have attacked the Star fort and batteries at a time when the whole defending force was only 11,000. Both Todleben and Lord Raglan believed the attack by the north the true policy, however, the combined north attack was abandoned and there appears no other factor of importance in this decision than a wholesome respect for the defenses. The delay further enabled the Russians to sink seven of their vessels in the entrance of the harbor and the remainder of the fleet were thus secured from the sea and were left free to concentrate their fire on the north side. Thenceforward the Russian fleet practically ceased to exist as a factor in the war, except as the men who had manned it were distributed as trained gunners, and the naval guns were thus drawn to the defense of the land lines, a not very important matter, for the communications with the Empire were never suspended nor interfered with until long after, and were never entirely cut off—great as were the services of the seamen and guns, there was no lack of guns in Sevastopol and shortly no lack of trained gunners.

As regards the question of the fleet engaging the forts, more

will appear further on, but as it did not attack before the entrance was obstructed, there can be nothing but surmise as to the result if it had done so. Again, if the allies had succeeded in occupying the north side, from the lack of safe harbors and with westerly winds on that side, the communication with the fleet would have been extremely precarious. Other considerations appeared, and many plans suggested themselves, but all but one involved in one way or another the jeopardizing of the line of communications with the base, the fleet, or at least the immobilizing of a large part of the army for the protection of that line. There is no need here to point out the complexity of the questions that present themselves to the officers in charge of such an expedition, and in forming a judgment on this disputed point, it is well to bear in mind that besides the width of the bay, nearly three-quarters of a mile, the Star fort was a very strong work surrounded by a deep ditch, and was entirely safe from the fire of the allied fleet, while its approaches were directly in range of the guns of the Russian vessels inside.*

The allied army now moved to the southeast, some of the vessels of the allied fleet engaging Fort Constantine and the Star fort at long range at the same time without effect, the base being changed to Balaklava by the fleet moving to that point. It is only important to notice regarding the flank march of the allies the precarious position in which they were again placed during that march by the loose manner in which it was made; the Russian army, having left Sevastopol in order to keep up the communications with Russia and crossing their line of march at right angles, being at one time actually in sight of the allied army. The Russians, however, incomprehensibly failed to seize the opportunity, and Balaklava fell into the hands of the combined land and sea forces on the 26th of September without difficulty, four shots only being fired by the garrison, which consisted of but seven officers and sixty soldiers. The heights inland from

* Sir Howard Douglass' opinion on this flank march is interesting and weighty. "The flank march of the whole army to the south was therefore an error in strategical science, imposed of necessity upon the allied commanders by want of numerical strength to render the attack of Sevastopol safe and successful, and such error can only be justified by the absolute inability of the army to fulfill the conditions on which the siege of a fortress, with a large army of observation in the field, can be successful."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Berezan Id.
Ochakov Pt.
Ochakov Channel
Kinburn Spit
Fort Kinburn.

Balaklava were quickly provided with fortifications to resist an attack from that quarter by the Russians.*

When the Russian commanders became aware of the change of front of the allies and its accompanying change of base to Balaklava and Kamiesh Bay, which was occupied by the French, all their forces in Sevastopol, amounting now to 35,850 people, were concentrated for the defence of the south side, the allied army now resting between the two points, the English on the right, the French on the left.

Passing over the burning questions of the moment to the allies concerning the relative merits of an attempt to carry the works by assault or to trust to the more certain, but infinitely slower, means of siege in regular fashion, which was eventually adopted, the next event of importance was one in which the allied fleets took a prominent part. At the time of this event, the 17th of October, the military situation was roughly as follows: the allied army were investing the southern side from the Quarantine to the Careenage, while the Russian communications were entirely open to the northward with the Empire, and a Russian army, posted for the purpose of keeping them open, was left free and unobserved by the allies. The plan of an extensive siege having been adopted, trenches were opened by the allies in the orthodox manner, but at distances considerably in excess of those laid down by the great masters of siege operations in the time of Louis XIV, the improvements in ordnance having made themselves felt. After much correspondence and consultation between the commanders, military and naval, it was agreed finally that a combined military and naval artillery attack, to be followed by an assault, should be made upon the stronghold. It will be remembered that the Russian fleet, or what was left of it, after the sinking of the seven ships in the entrance of the harbor of Sevastopol, was effectually sealed up in that harbor. It was realized that the ships of the attacking squadron might suffer severely from an engagement with the

*The allied armies marched in a long loose column, threading their way through an unknown country, and took little precaution against surprise. The Russian army could surely have doubled the line all up and secured a victory, but Menschikoff was so ignorant of the condition of affairs that he was writing to Sevastopol for information as to the movements of the allies.

fortifications, and at any rate there seems to have been no such confidence as would follow upon any assumption as to the superiority of ships in a conflict with forts. The object of the effective fleets had been simply to command the Black Sea, and their engagement with the fortifications was regarded with grave distrust, for in case of their being considerably injured the possibility existed for the sallying out of what was left of the Russian fleets. In any case the safety of the communications of the army, and consequently of the expedition itself, depended upon the efficiency of the fleet. The Russians might have done well to have heeded Korniloff as to these considerations.

In line between Fort Constantine and the Quarantine and Alexander forts were sunk three 84's, one 120, two 84's, and one 54, in the order given. Inside was a strong boom; further inside was a strong boom of chain cables floated by timber; between Fort Nicholas and the westward of Fort St. Michel, and again inside, were sunk, beginning on the north, one 60, one 84, one 20, one 84, and one 60; the remainder of the Russian fleet lying inside the pontoon bridge, consisting of four 84's, one 120, one 110, and three steamers. Near Inkerman were several sunken steamers, besides several brigs and corvettes. To abridge at this time what might be made a long discussion of dispositions and events preceding the action of the 17th, I will quote the following from Kinglake: "It cannot be said that the conclusion of those who judged Sevastopol safe against an attack from the sea was ever upset or shaken by the subsequent course of events. It is equally certain, however, that nothing occurred which could be used as proof by experiment that the place was impregnable against an attack from the sea, for no irruption into the roadstead was ever attempted by the allies, and the mere fact that an Anglo-French fleet lay hovering over the prey for a year and a half without breaking in to seize it has hardly so close a bearing upon the question as it might seem to have at first sight." Here he enters upon a discussion to show that an Anglo-French fleet is of less account than either acting singly, which, with all deference to the distinguished author, and granting all that can be said against mixed commands—assumes too much. He continues: "Seemingly, however, the reasonings of those who concluded that the place was impregnable by sea were as sound as reasonings of the kind could well be, for if an artillery adept

bends over a plan of the roadstead and marks out with ruler and pencil the scope of the fire from the forts as well as from the ships of the Russians, he finds the radii converging so thickly upon the mouth of the roadstead, and upon the waters leading on toward the man-of-war harbor, that, even though no obstructions be supposed like that of sunken ships, he sees pointed out upon the paper the assurance of ruin to a fleet which might strive to break in." And again: "However, there stands the fact that whatever might have been possible to such a man as Cochrane, invested with the sole command and untrammelled by the fetters of an alliance, the commanders of the Anglo-French fleet agreed with the Russians in believing that Sevastopol was safe against an attack from the sea. Therefore for the purpose of understanding the limit, not of what might be possible in the abstract, but of what could be done by invaders impressed with this belief, it may be taken for granted that although the Anglo-French fleet ruled unchecked over all the high seas, its dominion stopped short of the mouth of the Sevastopol roadstead." The author does not seem to have had in mind the immunity that such harbors as Sevastopol, or harbors less well defended, had enjoyed in the presence of fleets commanded by such men as Nelson, or St. Vincent, or Cornwallis. Continuing the author says: "It has to be said once for all that as means of breaking through that part of the enemy's line which consisted of seaward defences, the fleets were of no avail. In the roadstead and in all its creeks the Russian was master. Nor of this was there ever much question, for in judging the limits to which the allied fleets could push their dominion, the invaders and invaded were of one mind."

The troops in Sevastopol were increased, owing to the pleadings of Korniloff, from the Russian army in the field by 25,000 men, and the allied armies were increased in strength by detachments from the respective fleets. The cannonade between the siege batteries and the allies, which took place on the 17th of October, began early in the morning, and has been described as the greatest artillery duel the earth had ever witnessed up to that time. In the plans for the co-operation of the allied fleets nothing but a bombardment at comparatively long ranges was contemplated, and their co-operation at all was forced upon them by a complexity of causes, which will be referred to later. The very plans looking to the character of the operations to be under-

taken by the fleets underwent a change on the morning of the assault, the idea of bombarding while under way being given up. The fleets were anchored in a crescent-shaped line, the French and Turkish vessels having the southern end, beginning at Chersonese Bay and at distances varying from 1600 to 2000 yards from the Quarantine sea fort, the nearest, and from 1800 to 2000 yards from Fort Alexander; the English fleet at the northern end of the line at equal distances from Fort Constantine; a portion of the English fleet, and a fine one, was enabled to take position closer to Fort Constantine; and several steam frigates, the Samson, Tribune, Terrible, and Sphinx, a steam sloop, the Spitfire, a steam gunboat, the Lynx, and the ammunition vessels were left free to move about, these vessels being especially enjoined to aid disabled vessels. The allies were familiar with the defences of Sevastopol and knew that besides the batteries, only three of the forts could bear upon the ships keeping outside the entrance—Alexander, Constantine, and the Quarantine sea fort. Fort Alexander mounted in all 56 guns, 27 in casemates, 51 of the total number bearing upon the fleet. Fort Constantine had 97 guns. It was shaped like a horseshoe and was especially vulnerable in one direction, which direction was especially favored for the allies from considerations of the depth of water, and but 43 of its guns could bear upon the fleet, two tiers of guns were in casemates and one tier above in the open. The Quarantine sea fort had 58 guns, all mounted in the open, 33 of which could bear upon the fleet. Besides these, there were two small batteries on the heights above the northern shore, the Wasp and telegraph batteries mounting respectively 8 and 5 guns.

The Wasp battery was a small square tower elevated above the water 130 feet, concealed by its glacis. Of the 8 guns it mounted, the greatest estimate only allows 5 to bear upon the vessels; the Russians say one. The Telegraph battery was an earthwork elevated 100 feet, with 5 guns bearing on the fleet. The action of the in-shore squadron, from the power and mobility of the vessels composing it, from the nearness to which it could approach the fort and batteries, from the different character of the fortifications involved, and the varying immunity thus secured, becomes the most interesting, and will receive a little more extended treatment. The sailing vessels of the fleets were towed into position in the same manner adopted later by Admiral Farragut at Mobile,

and for the same reasons. The action of the fleets was divided, from its nature, into two parts—that of the main body anchored in crescent form, and that of the in-shore squadron. Without entering into details, the facts and results will now be stated. The fire of the fleet was from 1100 pieces of heavy artillery. The forts could bring to bear but 152 guns, of which 47 were in casemates. Kinglake says: "If this was the heaviest sea cannonade that up to that time had been known, it was also, in proportion to its greatness, the most harmless one ever delivered." The in-shore squadron consisted of the Agamemnon—the flagship of Lyons—and the Sanspareil (two powerful steamers carrying respectively 91 and 67 guns), the London, 90 guns; Albion, 90 guns; and Arethusa, 50 guns, as well as sailing vessels towed by steamers lashed alongside on the off side. Admiral Dundas, commanding-in-chief the English fleet, had issued hampering instructions to the captains of these vessels. He himself disapproved the attack upon the forts by ships, but his instructions being set aside by the captains, the engagement of the in-shore squadron was really a fair test in most respects. The Agamemnon was piloted to a most advantageous position by the Circassia, a small steam tender, where she anchored head and stern and warped into the desired position in an almost perfect dead angle of Fort Constantine, where but few guns could be brought to bear upon her, and where in turn she could rake the fort, besides taking it in reverse. The range was 800 yards; the Sanspareil anchored astern at 900 yards; the London astern of the Sanspareil at 1500 yards. Later the Arethusa and the Albion came into positions astern and opened upon the cliff batteries—the Arethusa at 700 yards from the Telegraph battery and the Albion at 600 yards from the Wasp battery. Still later, when four of the vessels (all but the Agamennon) had been so disabled that three of them had hauled off and one of them had changed her position, reinforcements came in the shape of the Bellerophon. The London again closed in and the Sanspareil resumed her old position. The Rodney moved in and also the Queen; in fact, all the English fleet with the exception of three vessels came sooner or later into contest with Fort Constantine and the two little batteries; the steamers under way taking part as well, but at greater ranges.

Interesting as are all the details connected with this fine en-

gagement, they will not be dwelt upon here. The results have been given tersely and strongly by Kinglake in full knowledge of everything connected with it, and will be given in his language, with but few comments.

"First. At ranges of from 1600 to 1800 yards a whole French fleet failed to make any useful impression upon a fort at the water's edge, though its guns were all ranged in open batteries and firing from over the parapet.

"Secondly. An earthen battery mounting only five guns, but placed on the cliff at an elevation of 100 feet, inflicted grievous losses and injury to four powerful English ships of war, and actually disabled two of them without itself having a gun dismounted, and without even losing one man.

"Thirdly. At ranges of from 800 to 1200 yards, and with the aid of steam frigates throwing shells at a range of 1600 yards, three English ships in ten minutes brought to ruin and cleared of their gunners the whole of the open-air batteries containing 27 guns, which were on the top of a great stone fort at the water's edge.

"Fourthly. The whole allied fleet operating in one part of it at a range of from 1600 to 1800 yards, and in another part of it at ranges of from 800 to 1200 yards, failed to make any impression upon casemated batteries protected by a good stone wall from five to six feet thick.

"Fifthly. Under the guns of a great fort by the water's edge, which, although it had lost the use of its topmost pieces of artillery, still had all its casemates entire and the batteries within them uninjured, a great English ship at a distance of only 800 yards lay at anchor and fighting for hours without sustaining any ruinous harm."

Commenting upon these findings, it will be well to notice in regard to the first that 73 fort guns responded to the 600 or more of the French, one-half their total number. Six guns in the fort in the open were dismounted, eleven men killed and thirty-nine wounded—the French fleet suffering heavy damage, which is not stated in detail, and losing 200 in killed and wounded. Nothing but imperfect aiming can account for this extraordinary result, the range, while great, not preventing great damage where hits were secured. The targets of the French were open batteries; as a matter of fact, the majority of the French pro-

jectiles flew to the eastward of the forts. In regard to the third, the extreme injury inflicted upon the upper battery of Fort Constantine was caused by a single lucky shell from the Tribune at 1600 yards, which caused the explosion of a store of ammunition, together with the fire of the Agamemnon, Sanspareil and London at close range delivered from the dead angle before mentioned. Kinglake, in another place, says: "What they (the ships) could inflict upon the open-air batteries proved to be sheer ruin, and what they could do against the casemates turned out to be almost nothing."

The masonry forts were built of slabs of white freestone, and were of great thickness, age having only solidified the works. After the occupation of the south side by the allies, and before the conclusion of hostilities (Kinglake's account ends with the death of Lord Raglan) the Russians kept up an incessant fire from the north side with the object of completing the work of destruction begun with their withdrawal from the south side. They knew, of course, the precise location of strong points, and their weak features, and under this precise fire the works crumbled easily. It seemed to have been demonstrated by this that some of the superiority of fixed works over ships would have disappeared if it had been possible, as in some former actions, such as at Algiers, Acre, or San Juan d'Ulloa, to have laid the ships quietly alongside the forts.

As regards the fifth finding, it is well to remember that the great English ship which lay at anchor and fought for hours had secured a most happy position, where, by the same authority, she enjoyed comparative immunity. In the Wasp battery, 22 men were wounded and one gun put out of action. The Telegraph battery suffered no harm whatever. The entire Russian loss in killed and wounded was 138. Two English ships had to be sent to Constantinople to refit, and many other vessels were seriously damaged. The losses in killed and wounded, exclusive of the Turks, was 520; the loss to the in-shore squadron alone was 300.

In this single duel between the in-shore squadron and forts some facts stand out in bold relief which, though only showing what might be expected from reasoning, as well, go far to confirm the experiences of other similar contests, notably, the futility of an open air arrangement of guns à fleur d'eau; the immu-

nity enjoyed by casemates at that day with overhead cover when their material and thickness were proportioned to the strength of the attack, as well as the limitations placed upon them which control the arc of fire of the guns, and the extreme of the offensive and defensive power enjoyed by mere earthenwork batteries placed at an elevation and masked. It would seem unnecessary to refer to the explosion on the top of Fort Constantine but for the fact that, through all the accounts of encounters between vessels and fortifications as well as in siege operations on shore, there runs a monotonous record of just such accidents, usually attended with paralyzing results. The lesson is obvious and is so simple that no elucidation is demanded. The main attack on the land front proved abortive largely, if not entirely, from the same cause, while the explosion of a quantity of ammunition in the French siege batteries on Mount Rodolph placed the French in such a position that they would have been unable to take part in the assault, and consequently the assault could not have succeeded. The siege batteries had accomplished on the land fronts all that was expected of them.

Looked at in another way, I think it is safe to say that the action of the ships was wholly resultless. With the weapons of the day and the defensive works it was recognized that decisive results could only be secured by close action. Close action meant, however, greater injury to the vessels, and that meant greater opportunity to the Russian fleet. The whole weight of testimony and reason goes to show that the harbor was impregnable to the fleet. No diversion was caused, for the operations on the land side and on the sea side were so widely separated in distance that all that could be expected was the withdrawal of men from the one side to the other, and the sea-coast batteries only needed few men more than their regular garrisons for their proper and efficient war service. The damage to the fleets was absolutely without any return, and as they could come to close action only by passing inside the obstructions and turning the outer works, which operations were impossible, it seems evident that half-way measures were worse than useless.*

*The cause of the damage sustained by the vessels was attributed by the allies to the use by the Russians of time fuzes of the same character as those used at Sinope.

Putrid Sea
Arabat Bay
Theodosia
Simferopol
Alushta
Yalta
Baidar R
Belbek R
Alma R
Katcha R
Baidar Pass
Kamishli Bay
Kalamita Bay
Eupatoria
Sevastopol
Balaklava
N
C. Tarkan

The attitude of the fleets before Sevastopol seems to have been a clear example of the manner in which fortifications in any way formidable had come to be regarded. The fact that the entrance to the harbor was efficiently obstructed exerted a profound influence, also, on the minds of the attacking admirals, already sufficiently impressed with the evil consequences which inevitably were sure to attend the entire expedition should any serious damage be inflicted on the fleet, which alone sustained that expedition. The action of the fleet, as it proved, produced not even a diversion, and it can easily be believed that had there been no obstructions in the harbor, and had the fleet proceeded to a main attack itself under the command of Lyons, who seems to have been the moving spirit of the occasion, though not the commander-in-chief, from the injuries inflicted by a few works. as it happened, that it would have suffered greatly and have failed ultimately, it will be remembered further that the forts engaged were provided only with their regular garrisons, and that the entrance of the harbor was the least defended portion of it. But this is only surmise, and it is quite impossible to separate the two attacks; success on either side of the city meant success on the other. However, if the relative losses under these circumstances are considered, as well as the fact that an attempt at entrance must have been made in column where the leading vessels would have been subjected to a fire gradually becoming more and more concentrated, while the following vessels would have been unable to support them, I am inclined to think it was a good thing for the fleet that there were obstructions. The action was further remarkable in calling attention anew to the value of command for batteries, and to the great exposure of open batteries à fleur d'eau. Almost every engagement between forts and ships in former wars had demonstrated these facts, and notice had been drawn to them repeatedly, but the teachings seem not to have been generally regarded.

While the casemated works engaged suffered only slightly, and the gunners being enabled to return to their guns at any time whenever the fire of the fleet slackened, the open batteries were completely silenced.

The Russian ordnance is said to have been superior to that of the fleets, especially in the matter of time fuzes, and it is also given as a reason for the little effect of the fire of the fleet that

its shell guns were of little use against the masonry, or rubble, of the works, the only guns of any use being those using solid shot, and yet it was the explosion of a shell that caused the damage on the top of Fort Constantine. This attack was made by the fleet without any especial appliances, and undoubtedly numerous mortar vessels would have been very effective. In speaking of the conclusion of the action, Sir Howard Douglass says: "In consequence of the little impression made, apparently, on the forts, when darkness was coming on the fleets retired to their anchorage." At this time the Russian batteries were in full fire.

Having referred previously to the differences of opinion which existed between the leaders of the fleets themselves, and between them and the leaders of the armies, the action and its results (or rather lack of results) having as well been briefly sketched, it may not be amiss, at this time, to look a little further into the situation to the end, perhaps, that a better sense may be had as to when and how it may be expedient to risk a fleet in action with coast defenses, or at least so far as a better sense may be had from the circumstances of this action. The French admiral was under the orders of the French General Canrobert. The English admiral, Dundas, and the English general, Lord Raglan, were not on cordial terms with each other, while the second in command of the English fleet, Lyons, was upon the closest terms of intimacy with Lord Raglan, and under secret encouragement from England had been upon the verge of taking action independently of Dundas. Lyons further constantly urged upon Lord Raglan decisive action, and up to the time of his in-shore attack was in favor of assault.

It has before been said that opinions, both Russian and allied, were largely in favor of the belief that the combined assault from the north side would have been successful, and also that the intended assault of the 17th was bound to succeed. It was even believed that the assault on the land side alone was sure of success. Yet to doubly assure success it was thought that the co-operation of the fleet was extremely desirable. A further factor in favor of this co-operation was the extreme eagerness of the fleet itself, which is said to have been so great as to endanger the maintenance of authority. This can readily be believed when the attitude of the second in command is considered,

and the general belief in the success of the attack, in which all wished to participate. The French admiral, under orders, and the English admiral, under pressure, agreed to the attack, and, while notifying the generals that the fleet had but 70 rounds of ammunition, requested information as to the time of the attack. They were informed that it would be advisable to divide the attack into two parts, one to be delivered coincident with the preliminary bombardment, the other with the assault. At a council held in the fleet subsequent to the decision, Lyons came to lose some of his ardor, and when before long, he came to the chief command, he never made any attempt upon Sevastopol whatever.

The admirals had no difficulty in concluding that the attempt at forcing an entrance was quite out of the question, close action, except in the case of the in-shore squadron, being as well put on one side, for the obstructions and the character of the water front generally forbade it.*

A forced entrance and a general close action being barred, there remained other alternatives, of which the one selected, bombardment over the entire front at long range, remains to be considered, and one or two others which found favor with Dundas. The one selected was confessedly weak, for with the ordnance of the day, the character of the works and their location, and the shortness of ammunition in the fleet, but one result could have been expected, and as it proved not even a diversion was produced. Had the land attack succeeded it can be said in the light of events that the credit to the fleet would have been gratuitous. In failure the Russians had the right to claim a victory over the fleet, which retired disabled and short of ammunition, the exhaustion of the ammunition being only a question of time and had been foreseen. In palliation for the form of attack adopted it has been urged that in case the bombardment on the land front had produced a panic in the city that the

*The situation was not unlike that at Charleston when the first assault was made, and a full appreciation of all the factors will go far towards enabling one to form a judgment as to Dupont's action, for which he suffered so in reputation. His opinions also as to the character of the operations to follow his failure, and Dahlgren's subsequent actions, also receive some light from this action at Sevastopol and the attendant circumstances.

fire from the fleet would have added to the confusion. This is undoubtedly true, but the careful and well-directed fire from a few steamers delivered at the right instant would have been fully as effective without entailing so serious results, and this instant would have been the moment for the assault by the troops; but the generals wanted the coincident bombardments.

On the evening before the action the French admiral notified Dundas that owing to the shortness of ammunition supply he would not open fire until ten or eleven o'clock, half past six having been the hour settled upon. On the morning of the attack the French admiral further notified Dundas that he would fight at anchor abreast the southern forts instead of under way, and declared he would fight that way whether the English fought or not. We have seen the results. The bombardment by the fleets in the original plan, to have begun at half-past six, was postponed by Hamelin to ten or eleven, and only commenced about one. At half-past ten, however, the explosions on Mount Rodolph made of the land attack a failure; consequently the naval bombardment, besides being resultless, was entirely pointless. Subsequently Dundas communicated to Lord Raglan that he had undertaken the bombardment against his better judgment, and should not assume the responsibility for its failure.

In looking now to what alternative methods there were available for the active participation of the navy in the assault, one of them is supported by the high authority of Dundas, backed by an almost unbroken historical record of success for such operations so undertaken; in fact, a method which brought success to some of the operations of the same war in both the Black Sea and the Baltic. It was, to make a double demonstration to the northward of the cliff batteries, where the water was suitable, by means of a landing party supported by the guns of the steam fleet. A formidable party could have been thrown on shore without difficulty, and aided by fire from the steamers could have menaced, if not have taken, some of the batteries to the north. Undoubtedly this method of attack would have created a diversion important if not vital. This movement would have thrown the main strength of the fleet upon a portion of the enemy's line, which is one of the soundest of military maxims. The Russians thus attacked in force on the whole land front to the south, an important flank menaced by both land and sea, and a large part

N
Perekop
Perekop Gully
Tarkan Cape
Dnieper R.
Nicolaev
Bug R.
Tendra Bay
Kinburn Spit
Odessa

of their line of defense completely isolated from participation, must certainly have made detachments for the purpose of averting this attack. Dundas desired this in the first instance, and next to this desired close action, which was denied him by the French admiral taking the south end of the line of battle, where lacking gunboats or especial vessels it was alone possible. Abreast of Fort Constantine the shoal extended 1200 yards, and in the turn to the N.W. of the contour, where a range of 800 yards could be secured, but one or two vessels could be advantageously placed, while still to the northward the position for large vessels was shown to be untenable under the high batteries which could not themselves be harmed.

The portion of the defensive line abreast the French position, however, offered a singularly favorable opportunity for close action which the French avoided. The Quarantine sea fort covered the entrance to the Quarantine inlet, and as before said, the guns were all mounted à fleur d'eau in the open, a form of battery which has always been considered as quite vulnerable to a close attack. Attacked as it was by the French from a distance, it was silenced but not seriously injured, the French shell, however, so covered the ground between it and the city that during the action but one man succeeded in passing over the zone. Only a portion of the guns of Fort Alexander could bear upon the French vessels, and here, then, was an opportunity for an attack which probably would not have been without results. An approach to the Quarantine fort to any desirable distance was, owing to the depth of water, quite possible, and Fort Alexander would have been still more marked. Considering that, as it was, the Quarantine fort was silenced, that it was also impossible to have reinforced it, it is not too much to hazard an opinion that the work would have been destroyed and that the fleet would have seized in the Quarantine Cove, a most important point, where a diversion might have been readily effected. In the course of this operation it still would have been 2000 yards from the north forts, which might readily have been occupied in returning the fire of a few vessels. A threatened landing in this Cove would have created an equal diversion with one to the north, though it could have been the more readily met by the Russians; yet it would have been as readily supported by the French left attack, and we have seen how easily the Cove could have been controlled.

Next in the order of events came the memorable action of Balaklava, which had for one result the narrowing of the allied outworks about the town of Balaklava placed on the heights above the town. Following this action, it was proposed to unite the two bases of the allies in one in Kamiesh Bay, but this scheme fell through owing to the professed inability of the commissariat to supply the British army without Balaklava. The position of the allies at this time seems to have been very grave—outnumbered both in men and in artillery, shut up in a little corner, depending wholly upon that command of the sea for every supply—while the Russians' resources were measured only by the size of the Empire of Russia, their only drawbacks, the length of their line of communications and the severity of the climate—and it is somewhat of a question which was the besieged and which the besiegers, while the allies further suffered from the evils of a mixed command. Granting the command of the sea so vital to an enterprise of the kind under consideration, and the fact that the allies were ready to replace any number of destroyed armies by fresh ones, I have yet to see any good reason why the army then in the Crimea was not entirely destroyed, save the incompetency of the Russian commanders and the lack of harmony or system in their actions in the field, which was plainly exhibited in the next bloody battle, that of Inkerman.*

Some of the reasons assigned for the Russian defeat at Inkerman were the mass formation in which the Russian troops fought, and the fact that the majority of their troops were armed with old-fashioned fire-locks, while the English, at least, were provided with the Minie gun, whence it followed that the Russian ranks were under fire and suffering before their own weapons were in any way effective. Sir Edward Hamley says in regard to the battle of Inkerman, that defeat in their position (the allies'), having only sea cliffs behind them, would have been absolute and ruinous, and behind such defeat lay national degradation. This is perhaps too strong a view of the situation, but well exhibits the uncertain tenure held by an invading force, and the desperate nature of the situation of the allies. The same authority, contemplating the allied success at Inkerman, says,

* In November the relative forces of the contending parties stood at about 110,000 Russian to 65,000 allies, the Russians having been reinforced from all directions.

after commenting on the fact that the Russians could not beat the allies in battle: "We could do nothing else but keep our hold, and, keeping it, it was a matter of demonstration that the powers which held command of the sea must prevail over the power whose theatre of war was separated from its resources by roadless deserts." And again: "the defeat of that slender division on its ridge would have carried with it consequences absolutely tremendous." Yet another clew to the success of the allies may be found in the official report of the commission sent by the English ministry to investigate the condition of affairs in the Crimea, after the months of suffering following the battle of Inkerman: "Both men and officers, when so reduced that they were hardly fit for the lighter duties of the camp, scorned to be excused the severe and perilous work of the trenches lest they should throw an undue amount of duty upon their comrades, yet they maintained every foot of ground against all the efforts of the enemy, and with numbers so small that perhaps no other troops would ever have made the attempt." The work of the siege went on, and it is interesting to note that it was considered important to make the Malakof an early objective for a reason urged by General Sir John Burgoyne, that a few guns placed there would effectually rid the allies of the fire from the Russian ships in the harbor.*

*It was the possession of just such a tactical position in the harbor of Toulon that Napoleon seized upon as the key of the position at the time of the English and Spanish occupation. It will be remembered that the city was invested on the land side by the Republican troops, and in a council Napoleon pointed to one position, the possession of which would make the harbor untenable for the fleet. His advice was taken, and with the gaining of that point the withdrawal of the fleet commenced, and when the harbor became untenable for the fleet all the resources of the city failed. As this siege of Toulon has been taken as the starting point of Napoleon's greatness before the world, so this particular incident of the siege, where he displayed such unerring judgment, is regarded as the particular point where his fine military judgment was first made apparent. It may not be amiss to notice the circumstances more in detail, for the situation was unlike the one in the Crimea before Sevastopol in that the command of the sea rested with the besieged, the city being invested from the side of the land only. Napoleon seized upon the idea that to succeed the communication of the allies (that is, by sea) must be threatened. Conditions favored, and one point offered itself to his mind as fulfilling them. The Repub-

The hurricane of the 14th November caused great havoc among the vessels in Balaklava and Kamiesh; ammunition and store ships were destroyed, twenty-one vessels in all being wrecked. This hurricane was the beginning of the miseries endured by the allies, especially the English and Turks, which lasted until February of the next year, at which time the allied troops numbered not less than 100,000 effective men in spite of the losses from all causes. The intervening months were occupied in various minor operations, but in February the Russians, fearing for their communications, attempted to drive the Turks, who had entrenched themselves there, out of Eupatoria. The Turkish lines formed a salient landward, and each flank was covered by the guns of the allied steamers, six of them being thus moored, but the assault of the Russians failed in every particular. In February, also, the Russians sunk six more vessels to make good the line of obstructions at the mouth of Sevastopol harbor, which had become somewhat disintegrated by the action of the sea, thus forming an inside line of obstructions.

In March the English opened with some hot shot upon two warships in Careening Creek, which had been annoying the French, and drove them out of their position. It cannot too strongly be dwelt upon, in the rapid review we are making of the operations of this war, that the command of the sea was enough to ensure at all times, when the public spirit of the home governments was sufficiently aroused, that reinforcements could be poured into the Crimea without any limit. It was also the pet project of Napoleon the Third largely to increase the force of the allies and wholly to invest Sevastopol, the French to furnish the troops, the English the transport. Of course this was perfectly feasible, and after Inkerman everything seems to have been possible to the allies. This scheme, however, fell through for

lican general, Carteaux, did not grasp the idea, and meanwhile the English did, the point d'Eiguillette being seized by them and fortified, Fort Mulgrave also being thrown up. A second leader also failed to support Napoleon's idea. The third to succeed to the command, Dugommier, fell in with the project, and orders were given to carry the point by assault. The assault took place by night and succeeded. Napoleon at once threw up batteries of guns and mortars and opened fire on the fleet, and at noon next day the troops embarked.

various reasons, principally because the responsible leaders thought the time had gone by for such an attempt, and that the siege should be pushed, as commenced, to a conclusion.

However, a French army of reserve was assembled at Constantinople and the French steamer fleet was detached from the Crimea to bring this army to the scene of operations. Difficulties engendered by the sometimes conflicting interests of the allies ensued—whether to follow the bent of the French Emperor in the idea of the complete investment of Sevastopol, or to continue the siege already so far advanced, was not yet settled, but a compromise came to be effected resulting in operations between vessels and fortified places, which now come in for some attention. In the meantime, however, on the 9th of April, the allies began a tremendous bondbardment upon the works of Sevastopol, having received great accessions of munitions, the most valuable of which were mortars. On the 19th the bombardment ceased, and the work in the trenches recommenced. Great damage had been inflicted upon the Russian works, but no assault followed owing to the diverse desires of the allies at home and in the Peninsula. On May 30th a combined expedition, consisting of 12,000 troops and 40 vessels put to sea from Kamiesh and Balaklava for the purpose of operating by water against the great Russian line of supply by the way of the Don, the Sea of Azov, and from Kertch, or Arabat Spit, to Sevastopol on land. The French part of the expedition, however, was recalled by a fast steamer under telegraphic instructions from France, and the expedition was consequently abandoned. On the 22nd of May, the French having changed leaders, another expedition embarked from Kamiesh with the same objects in view. The troops numbered over 16,000 men in transports convoyed by 12 men-of-war. This expedition to the Sea of Azov had no plans for occupation; it was one of destruction and to break the Russian communications, for, as the river Don offered the best means for throwing supplies into the Peninsula, the Sea of Azov was consequently filled with supply ships and its shores covered with storehouses, the Russian forces on the shores of the Sea of Azov numbering 9000 men.

The Russians, in their preparations, did not contemplate any serious resistance at Kertch or in the Straits of Yenikale—Arabat was the point where their saving energies were to be directed.

However, seven good batteries were mounted at Kertch (in all 62 heavy guns were mounted in the Straits) and some vessels were sunk for obstructions, some filled with explosives with electric connections. The channel at Yenikale was difficult and narrow (1¼ miles broad) and easily commanded from both sides. The plan of the allies contemplated the seizure of the works at Kertch by a coup-de-main. The Russian commander, as Kinglake says, "succumbed to the power (of which the world will learn much in time yet to come) the power an Armada can wield when not only carrying on board a force designed for land service, but enabled to move, to manœuvre, at will against an army on shore. The power would be of great urgency under many conditions, but especially so if it happen that the defender of the coast has in charge highly valued possessions divided, the one from the other, by several miles of ground." The Russian commander in presence of this fleet which by its mobility could threaten both points so vital for him to hold, one Kertch, by Kamish Burun, and Arabat Peninsula, by Theodosia, separated by about 70 miles, while he could not divide his forces to hold them both, chose Kertch for abandonment.

The English landed at Kamish Burun, as intended in the first abortive expedition, without opposition, the Russians ruining their own batteries and destroying their grain. A dashing engagement took place under the fire of the batteries between an English gunboat and some Russian gunboats endeavoring to escape into the Sea of Azov, but the Russian vessels being finally outnumbered were destroyed by their commanders, the remaining Russian vessels, save four, also being destroyed by their crews, while the four comparatively powerful steamers escaped into the Sea of Azov. The allied vessels then entered the sea, the channel being buoyed in advance. In view of the destruction of the fleet and batteries in the Straits by the Russians, it is unnecessary to look at their relative strength as compared with that of the allies. There being no retreat for the four escaped steamers of the Russians after the entrance of the allies, owing to the shallow water at the mouth of the Don, their destruction was also ordered. The allied fleets with the aid of a landing party destroyed the shipping and stores at Berdiansk; the next day engaging the fort at Arabat and blowing up a caisson of ammunition, and on the following day Ghenischesk's

stores and shipping were destroyed without resistance. A few days later the operation was repeated at Taganrog with some small river steamers and the Coles raft and pinnaces mounting 32-pdrs.*

No effective resistance was offered by the defenders at Taganrog as not a mishap was experienced by the attack, and there appears to have been no attempt to fortify the place, other places also yielding without any resistance. From all the operations in the Sea of Azov the allied loss was three men wounded; the Russian loss of combatants was a few score killed or wounded. Sujak Kale, on the eastern shore of the Black Sea, was abandoned on the approach of the allied fleet, 60 guns and 6 mortars being destroyed; Anapa likewise being abandoned with 114 pieces of artillery. The results of this expedition involved the loss to the Czar of nearly 500 vessels, 340 guns, and immense quantities of supplies. Kinglake, remarking upon the ease with which the expedition accomplished its objects, says in effect, that if executed (the expedition) when first urged, the war would have been brought to an end at the time of the Vienna negotiations. In these operations fortifications played no part, being abandoned with but the slightest, if any, effort to hold them.†

Little or no harm was done to the fortress at Arabat, the allied fleet bombarding it for several hours and nearly silencing it, but withdrawing without reducing it; a result to be looked for where the landing force does not appear, and the Russians claim to have driven the vessels off. A detachment was left at Kertch to intrench itself and to hold the entrance to the sea. This detachment was soon under observation by a Russian corps.

The results of this expedition were, then, confined to the destruction of stores and to the gaining of the command of the entrance. Afterwards, when the allies were obliged to contract for grain from the United States, they remembered this destruction. There yet remained in the Sea of Azov a line of communications which had not been endangered, that by the Spit of Arabat, and nothing but a land force posted at Arabat or on the

*I believe this was the first appearance of the type of vessels known as Coles raft, which in the English mind was the pioneer of the turret ship. It was simply a wooden raft mounting a 32-pdr.

†The Russian forces about the Sea of Azov did not number above 9000 men.

neck of the Peninsula could have cut that line. The Russians had now been reduced to such straits and to such passive resistance that the question "what to do" had become a vital one. Todleben, seriously wounded, having withdrawn from the city, the situation was discussed in council, several alternatives presenting themselves for consideration. The Russian army in the field might assault the allied position, either singly or assisted by the garrison of Sevastopol. It might reinforce that garrison in the city for passive defense, or in combination with the garrison, attack the allies in a sortie. The first alternative was chosen, and the battle of the Tchernaya took place, which resulted in a disaster to the Russians, and the siege was evidently drawing quickly to a close—that close so signally characterized by the famous assaults upon the Malakof and Redan batteries. The abandonment of the south side of Sevastopol began immediately after the final assault of the allies by the withdrawal of the garrison to the north side, after blowing up all the magazines and works possible, and was completed on the 11th day of September by the sacrifice of the remaining Russian vessels. The Russian army, now relieved of the necessity of defending Sevastopol, took up a strong position, beginning with Inkerman and along the main road behind a chain of heights, and one division was observing the Turks in Eupatoria. Their positions were threatened on both flanks, but the allies were forced to retire.

The fall of Sevastopol did not end the war, and other operations were necessary to bring Russia to terms, though she had lost nearly 250,000 men and the resources of southern Russia were exhausted. The continuance of the war and its conduct were differently regarded by the various powers, but in the end they acted in concert. England had come to be the strongest factor in the combination. Her fleet, troops, and their condition had augmented and improved to the extent that she felt equal to the carrying on of the war single handed. The position of her troops entrenched in Sevastopol with the sea free behind was no longer precarious, as it had been up to the battle of Inkerman with the same command of the sea, and it was greatly better than had been the position of the Russians, for the sea route furnished a better line of communications than did the land route, and a strong position backed by the command of the sea widely differs from a weak position with the same backing.

It having been resolved to undertake other operations, Kinburn was selected as an objective. Kinburn is a long spit commanding the bay where join the Dnieper and the Bug, and connected by a good road with the delta of the Dnieper; consequently its possession by the allies would cut off another important line of communication for the Russians, besides threatening the line by the Isthmus of Perekop. Various works guarded the approach to the bay, whose navigation, in addition, was very intricate. Kinburn Fort itself was a regular casemated work of stone, mounting, at the outside, 41 guns en barbette, 6 in casemates, and 12 mortars. North of it was a sand battery mounting 10 guns, and still north of that was another sand battery mounting also 10 guns, all small 18 and 24-pounders, other guns of heavier calibre and more recent manufacture being on hand but not mounted. Across the mouth of the estuary from Kinburn Spit was Fort Ochakov, a weak affair mounting few guns, on a cape a mile and a quarter distant. The passage or channel, in, is not more than three-quarters of a mile from the forts. Berezan Island stands across the mouth of the bay, but was unfortified. To the westward of Fort Ochakov were three small batteries, mounting, one five guns, the other two, three each. The distance from Kinburn to the delta of the Dnieper is about 30 miles, and the delta itself a most difficult piece of navigation about 15 miles in extent before the river proper is reached. Nicalaev, the present naval arsenal, lies on the Bug about 35 miles above the mouth of the bay. The river from that point to Nicolaev is between two and a half and three miles broad. Its navigation, like all the waters about, being very intricate. The bend at or below Nicolaev is narrower than the lower part of the river, and the shores at that point were well fortified, the river itself being obstructed. On the right bank of the river, about seven miles above the actual mouth, a spit projected into the stream, narrowing the channel considerably. In a fissure in the face of the cliff were mounted four guns of good size and elevated about 100 feet, these guns commanding the entire width of the river. All the shores were provided with telegraphs and patrolled, and field artillery moved from point to point, the distance from Kinburn to the Isthmus of Perekop being about 90 miles. The work before the expedition was to gain possession of Kinburn and its opposite fortifications, and from these points to

strike other objectives, either by water or by the road before mentioned connecting Kinburn and Chesme. The English part of the expedition consisted of 6 line-of-battle ships, mounting 583 guns, 17 steam frigates and sloops mounting 247 guns, 10 gunboats mounting 28 guns, 6 mortar vessels and 10 transports. The French had 4 line-of-battle ships, several steam frigates and a number of gun and mortar vessels. In addition there were three steam floating batteries—the Devastation, Lave, and Tonnant—carrying 22 50-pounders each; they were 172 feet long, 44 feet broad, the sloping sides being covered with 4½ inches of iron with a 17-inch wood backing. They had been prepared when it had become apparent through other operations that vessels of an especial type were required in siege operations, and it appears that they resembled somewhat the Confederate type of ironclad.

The expedition sailed from Kamiesh on the 7th of October in full sight of the Russians on the north side of the city. The rendezvous was 5 miles S. by E. of Odessa. On the evening of the 8th the expedition, numbering upwards of 80 vessels, anchored off Odessa, and some small, swift steamers left to reconnoitre the proposed theatre of action. Odessa lies close to the water, a little elevated above it. The water front was lined with casemates and other works provided with numerous guns. Yet this was a case where vessels could, with considerable impunity, bombard the city. The range was immaterial, as the target was a city, while for the shore defenses close to the city the target was only ships at a distance. Both the English and French commanders were opposed to bombarding. It seems there is little woodwork in the construction of the city. The experience at Sevastopol, where the city so long had undergone a bombardment, when it had suffered really so little from the Russian endeavors to destroy it, was remembered. Great damage and distress might have been caused by a bombardment, but before destruction or subjection could have been secured the ammunition would have been dangerously low. The proposition to bombard nightly with a few vessels was also rejected, on the ground that it would have to come to an end, and then the Russians might claim a victory. The mere matter of standing in and bombarding open coast cities does not appear to be the simple affair we so often hear it made out to be. Russell asserts that

the fleet did not carry ammunition enough to lay Odessa in ruins, but the demonstration had the effect of drawing troops from the intended point of attack, and while the fleet lay before Odessa every effort was made to produce the impression that the city was to be attacked. The general orders for the attack on Kinburn provided that the line-of-battle ships were to anchor in line ahead, abreast Kinburn Fort and the sand batteries, and at a distance of about 1200 yards, with the French ships forming the south of the line. The southern ship, as the guide, was to bring Kinburn due east. She was to be preceded by two sounding vessels. This would bring a due portion of the line-of-battle ships to act against each work, and in approaching would minimize the danger from the fire of the works. The floating batteries were to be placed S.W. from Fort Kinburn in line ahead at a distance of 600 yards. The mortar vessels were to be moored in an east and west line extending from the shore south of the fort and about 2800 yards from Fort Kinburn. Some frigates were to take position ahead of the line-of-battle ships, while some of the smaller steamers and gunboats were to take positions in the intervals between the other vessels. Some were to enter the bay and attack and enfilade the works from that side, and some were to cover the landing of the troops. The frigates were to be posted as shown in order to be at hand to support the gunboats in the bay in case they were attacked by vessels proceeding from the Bug. Vessels were told off to buoy the dangerous shoals in advance, and on the 14th of October the fleet weighed from Odessa and anchored in the afternoon three miles west of Kinburn. On the 15th the troops were landed unopposed four miles below the fort, and immediately intrenched themselves. From these intrenchments they advanced and opened a parallel at 700 yards distant from the fort, on the morning of the 17th. On the same morning the fleet moved in as arranged, the floating batteries, gunboats and mortar vessels preceding, and opening fire about 10 o'clock. The line-of-battle ships followed with precision, some of the heavy ships entering the bay in addition to the gunboats, delivering their broadsides in passing, and taking up flanking positions.

It is not worth while to enter into further details. The buildings interior to the fort were soon in flames, magazines were exploded, and shortly not a single gun could be served. It is diffi-

cult to imagine any fortification standing under such circumstances. The fleet had taken a commanding position where it had isolated Kinburn Fort from its supporting works on the north side of the entrance, and completely overwhelmed it. The defense was as brave as possible, and only ceased when not a gun could be fired. In Kinburn Fort 29 guns were completely disabled. On the 18th the Russians mined the fort at Ochakov, and a body of troops set out on a reconnaissance toward Kherson, supported by a squadron on the left flank. On the 20th the French admiral stood in for the bay, and shortly after an English squadron stood in to the bay, both bound for the Bug and the mouth of the Dnieper. The French squadron ascended the river as far as the Spit without seeing anything and then returned. The English commander determined to have a look and went up in the Stromboli, a steam sloop, and with a number of gunboats. Upon arrival off the Spit the cliff battery, before referred to, and the field artillery opened upon the squadron, when a small engagement followed, the Russians firing short to draw the English in. The engagement was unimportant and unnecessary, but illustrated again the value of high command for batteries and of invisibility, while the squadron could easily have run by the batteries. Russell says: "When you came to squint along a gun and saw only four little black eyes staring at you over a parapet of earth which did not seem three inches high, you began to understand the difficulty of striking such objects." It was completely recognized that no successful demonstration could be made by vessels alone against Nicolaev, and troops sufficient for a coup-de-main had not been provided. The vessels would have had to encounter batteries, obstructions and gunboats, besides being continually under fire from flying batteries. On the 21st a small French squadron stood up the river and anchored off the Spit at 1500 and 1800 yards and opened fire. Shots were exchanged for half an hour, and the French claim to have dismounted one gun. The reconnaisance by land towards Kherson succeeded in laying waste the country for a number of miles. The mouths of the Dnieper and the Bug were blockaded, and no attempts whatever were made by Russian vessels supposed to be at Nicolaev to inflict any damage.

The main body of the fleet was held at Kinburn in the meantime, and sailed on the 29th for Kamiesh, leaving a garrison of

N.
Taganrog
Mariupol
Berdiansk
Azov Sea
Arabat Spit
Perekop
Simferopol
Sevastopol
Balaklava
Kerch
Strait
Kazantip
Bay
Sivash
Crimea
Arabat Spit
Big R.
Perekop
Turkish
Sevastopol
Balaklava
Kerch
Strait
Kinburn
Spit
Odessa
Danube R.
Varna
Bosporus

French troops in Kinburn Fort, which had been restored and armed with ship's guns, and a covering flotilla was also left. The position was made so strong that even in winter, when the straits were frozen over, no attempt was made upon it. The expedition had accomplished part of its work, but the line of communication by Perekop was still open. In December Kars fell into the hands of the Russians, but its fall had no effects on the situation in the Crimea. It only saved their pride a little, and counted later in a trade for Sevastopol. The winter was passed in destroying the docks and fortifications, and on the 30th of March, 1856, the treaty of Paris was signed. In this treaty the Czar and the Sultan engaged not to establish or to maintain upon the Black Sea any military or maritime arsenal.

A brief retrospect of the situation at the end of the war and its events will show wherein the navy as an important factor succeeded and wherein it failed, where it was properly or improperly used in coast attack, and its dependence for complete success upon adequate support from landing parties. In the first place, concerning the disputed point as to the possibilities of a combined attack upon the north side and the flank march, it is absolutely impossible to form a satisfactory opinion. The Russians, with Todleben at their head, have insisted that the attack if made undoubtedly would have succeeded, and that the defeat of the Alma had so filled them with consternation that for three days they had no thought of making any defense. The flank march was discovered from the tower of the Naval Library, and when communicated to the leaders in Sevastopol and to Menschikoff in the field that they took heart. "Give me five days and I'll mount three guns to their two," said Todleben, and he did. They claim that an immediate assault on either side would have succeeded. Everything, and the great weight of authority, seems to point to the fact that a direct attack on the north side by the fleet and the army would have succeeded at once, but for the circumstance pointed out by Sir Edward Hamley that the harbor was efficiently obstructed before the assault could have been made. A military afterthought has given cause for congratulation that the place did not fall at once, which, while outside the subject, is interesting. It is to the effect that peace was forced upon Russia through her military exhaustion, caused by the tremendous efforts she felt compelled to put forth to sus-

tain the siege, and that better terms were thus secured for the allies. The precarious condition of the allies, in spite of the absolute command of the sea, has already been pointed out. A defeat at the Alma, at Balaklava, or at Inkerman might not have been fatal, but it may be surmised that such might have been the case. The necessity for sufficient and well-handled landing forces, as pointed out so insistently by Admiral Colomb, is certainly emphasized. The converse is equally true for the power whose country is invaded, not to give battle without a good chance to make it decisive. Menschikoff has always been severely criticised and blamed on all sides for his course in considering at vital moments his army in the field as of the first importance, and the safety of Sevastopol as secondary. The reinforcements that were thrown into Sevastopol before the first attack were only wrung from him with the greatest difficulty. Yet it may be believed, in view of the near approach he made to victory at Inkerman, that he was, in the main, right. A victory over the allied forces meant the safety of Sevastopol, and although, as it was said, Sevastopol was the kernel of which the Crimea was but the shell, the kernel would have been better preserved by military successes in the field than by sustaining a siege. In the actual attack made by the fleet upon the fortifications, under the circumstances surrounding it, it is hard to discover any merit. The most valuable services rendered by the fleet in addition to the vital one of maintaining communications were the attempts on the Russian lines of supply, and herein it seems to have done all that was possible. Where complete success was not attained the lack of landing forces is apparent, whether the condition of affairs or not allowed them to be detached for that duty. At the end of the war the Russian army in force and fairly well provided for, lay about Bakchi Serai and Simpheropol in a central position. The allies were based in Kertch, Baidar, Balaklava, Kamiesh, Sevastopol, Eupatoria and Kinburn.

The Russian communications had been destroyed by the navy, by the Don, by the military road in Circassia, by the Bug, and between Nicolaev and Kherson by Kherson Bay. They remained, however, intact by the Spit of Arabat, by a road through the Mud Sea, by Perekop, and between Odessa and Kherson by land. To have cut these lines it would have been necessary to

have seized Nicolaev, Kherson, and perhaps Perekop, to have destroyed Ghenischesk, and to have held the country about Arabat. All this belonged to the army, and none of it was done. The Crimea never suffered a military occupation nor did Sevastopol itself, in the true significance of the term. The war was brought to a close through the exhaustion of the Empire, with the hostile armies still facing each other.

In this short but hard-fought war it would seem that the navy, mistress of the sea, did all, as it happened, that could possibly have been done, nearly all that belonged to it to do, and in one case, at least, passed beyond the limits of safe and reasonable action. Such destruction as it inflicted was done as a military necessity. We certainly do not see the battle fleets, mistresses of the sea, turning their power of attack and destruction, lacking adversaries worthy of their steel, against all the cities of the Littoral, fortified or not fortified, peaceful or warlike, burning them, destroying them, or bleeding them without mercy. We do see, however, where in attacks of certain descriptions upon a coast the efficiency of a navy stops short at a well-defined point.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

MILITARY OPERATIONS AND DEFENSES OF THE SIEGE OF PEKING.

By CAPTAIN JOHN T. MYERS, U. S. Marine Corps.

Having been requested by the Naval Institute to submit an article under the above caption, the writer will endeavor to briefly set forth the salient features of the defense of the Legations, or more properly the defense of the United States Legation, as it is recalled after a lapse of two years. To the more complete understanding of the situation, a sketch map is submitted herewith, which will be referred to from time to time. This map is drawn partly from memory and partly by consulting a sketch which appeared with an English newspaper's account of the siege. Two of the bastions on the wall are shown on a larger scale than the rest of the drawing in order that the ramps and wall barricades might be put in.

The guard was drawn from the Oregon and Newark. The Oregon contingent, one (1) officer and twenty-five (25) men, left their ship on one hour's notice and embarked on the Newark, from which vessel they landed on May 29, 1900, reinforced by one (1) marine officer, twenty-three (23) marines, medical officer, one (1) hospital apprentice and three (3) bluejackets with a Colt gun. The necessity for haste was such that the entire detail arrived in Peking with heavy marching order only, their baggage being all left behind to be sent up later. The destruction of the railroad prevented this, and the men suffered before the end of the siege for want of proper clothing and shoes.

The guards of the various nationalities marched into their respective legations at about 9 p. m. on the night of the 31st of May. As the American guard wheeled into line in the legation yard, they were not a little startled, and entirely dazzled by

a blinding flash. When the smoke cleared away it was found that there were no casualties, only a guest of the American Minister taking a flashlight photograph. The minister had provided quarters for the guard by securing buildings (marked A on the map) in the rear of the Russian bank and Imbeck's store. These were reached by a doorway cut through the legation wall, and also had an entrance on the street in rear, directly under the Tartar City Wall. The situation of the United States Legation for defense was not a promising one. A rectangular compound bounded on the north and east by Chinese shops and houses, on the west by Legation street and on the south by Imbeck's stores, low, rambling buildings.

The main guard was established at the legation gate and the sentries posted at various points of vantage in the grounds. Outside the gate, a Chinese guard of boy soldiers armed with fans and spears were supposed to protect the legation; these vanished when the first shot was fired.

On the 7th of June, after we had been there a week, a meeting of all the guard commanders was held in the British Legation to decide upon plans for the common defense. The general plan was to hold all the legations as long as possible, to hold the Tartar wall in rear of the United States and German Legations, to send all non-combatants into the English Legation, as it was the largest, with the most commodious quarters; to stock this legation with all available food and live stock; to barricade all streets and to keep open the communications between the various legations.

The reason for holding this Tartar Wall was obvious; first, because it directly controlled all the legations, and second, because the water gate through it gave us means of communicating with the outer world. It was through this gate that the British Indian troops entered to the relief.

On June 13 some excitement was created by a Boxer brave appearing in Legation Street waving a naked sword. He was run down and arrested by the German sentries, but the rapid assembling of a mob and their demeanor showed that the time had arrived to barricade the streets leading through the legation quarters and to divert the traffic of the city to other channels. The authority of the Tsungli Yamen or Foreign Office was accordingly obtained to erect barricades on the principal

streets and proclamations were furnished by that office to be posted on such barricades, commanding the populace to respect them. The first barricades were erected solely with a view of stopping traffic and not with any idea of defense against rifle fire. They consisted for the most part of Peking carts turned on end "Chevaux de Frise," filled in with planks, beams torn out of Chinese houses, any odds and ends that could be found to be piled up in form of an obstruction.

The Russian Legation being directly across Legation Street from ours, the Russian sailors and Cossacks worked in common with ours in building, and later on, defending the barricade which joined the two compounds, and although entirely unable to communicate with each other by word of mouth, appeared to find gestures to answer all purposes. The Russian commander, Baron Rhoden, spoke English a little, German and French perfectly, so communication between the officers was made possible, and the hearty co-operation of this Russian officer in all matters pertaining to the joint defense contributed greatly to its success. One Russian institution greatly appreciated by the American officers was the ever-burning samovar in the Russian Legation, ready to make tea "at all hours."

From June 9 to 20, twenty men under Captain Hall were detached on the defense of the Methodist Mission, where a large number of refugees had sought shelter. These buildings lay some three-quarters of a mile from the line. An elaborate system of defense was prepared there; barbed wire entanglements erected, earthworks constructed and trenches dug, but owing to their distance from the rest of the legations and the fact that they were controlled by the wall and the Hatamen Gate, these buildings were abandoned on June 20 and the refugees brought into the English Legation as per the plan of defense spoken of before.

The question of food supply for the men was settled by entering into a contract with a Chinaman to supply us with three good meals a day at seventy-five cents Mex. per man. This he faithfully lived up to until the fighting began, when he cast his lot with ours and remained faithfully at his post assisting in the cooking of the ration served from the common stock. When it was seen that a siege was inevitable, the two European stores within the lines were systematically emptied of all edibles, under

the supervision of an officer, and all available food sent into the English Legation, together with large stores of rice taken from the Chinese shops. All horses, mules and racing ponies were sent into the English stables, where they were fattened for the fate which eventually befell all except about ten out of some hundred which had been driven in. It was not amiss during the siege to ask if "the horse had been curried," and in this form they proved most acceptable. Mr. Squires, the secretary of the United States Legation, who later, upon the death of Captain Strouts, became chief of staff to Sir Claude McDonald, took charge of the commissariat for the American guard and saw to it that the suply of food was regular. Upon first arriving at Peking we were at some pains to boil all our drinking water, and a man was especially detailed for this duty, but when the siege began in earnest this was found to be impracticable, and the wells had to be depended upon. Only two cases of typhoid appeared in the American guard, and in both cases the patients had been previously debilitated by wounds. From the 14th of June until the 20th, the feeling of uneasiness deepened among the residents in the legations and one by one all of the foreign buildings, churches or stores, outside of our lines, were set fire to by the mobs of Boxers. On the night of the 14th the uproar in the Chinese City beggars description. There was little sleep that night in the legation, as an attack was momentarily expected, and the preparations for defense were entirely inadequate.

During these few days prior to the first attack, several expeditions were sent out from the legations for the purpose of succoring Chinese Christians, penned in the burning districts by the Boxers. These expeditions were uniformly successful in rescuing large numbers of the persecuted Chinese and suffered no casualties, although inflicting heavy punishment on the Boxers and their attendant train of pillagers. It was realized at the time that these rescuing parties served to inflame the Boxer element more deeply against the foreigners, but it was more than flesh and blood could stand to see the terribly burned and lacerated bodies of those who escaped to our lines, and refuse to send aid to their comrades known to be still within the power of the fiendish Boxer hordes.

Up to the 18th of June the Foreign Office had been loud in

their promises of protection and protestations of eternal friendship. On this date the news of the attack on the Taku forts was known in Peking, and the ministers were informed that a state of war existed, and that all foreigners must leave. The assassination of the brave Baron Von Kettler, while on his way to the Foreign Office, put an end to any thoughts of trusting ourselves to the protection of the guard of Chinese soldiers so kindly offered. This occurred on June 20, and at 6 p. m. that day the legations were fired upon on all sides. The besieged had not been idle during the days of uncertainty, and all barricades had been more or less re-enforced with brick, beams and stone torn from the demolished Chinese houses within the lines.

In this work of demolition the German troops were of great assistance, as in each squad one or two men were found whose bayonets had a saw edge on the back. A beam 6 by 6 inches could be cut through after some hard work, and when the key beam was cut through the roof would fall and the walls could be pushed over.

Later in the siege, when it became necessary to fight fire, many buildings were destroyed in this way. All barricades had to be built double, that is to afford protection from the rear, as the long-range rifles (Manlicher) of the Chinese, fired at all angles and directions, simply filled the air with projectiles and one could never know from which direction the shot might come. Dr. Lippett's wound was a case in point; he was just leaving the minister's house, crossing a space which was nightly filled with sleeping men, as it was considered protected, when a stray bullet coming from the direction in which there was no hostile Chinese for at least 1,500 yards, brought him down with a bad fracture of the leg.

Directly in the rear of the United States Legation, separated by the street, arose the Tartar City Wall. This solid structure was 45 feet high, 50 feet wide on the bottom and 40 feet wide at the top. The sides and top were built of large bricks, about 1½ feet long by 9 inches wide and 6 inches thick. On the top of this wall, on the sides are parapets, that outside being high and crenelated, and inside low. Every 100 yards a bastion juts out towards the Chinese city, the first houses of which are distant about 300 yards. On the inside two double ramps give access to the top of the wall, the one being directly in rear of

the United States Legation and the other in rear of the German Legation. (See large map.) We found the top of the wall to be about six layers thick of the bricks spoken of before, which made the construction of the shallow trench in rear of our wall barricades very difficult. The centre of the wall is filled in with rubble.

After the Chinese troops had begun to fire on us from the wall, they were driven off, first by the Germans and later by ourselves, and a position fortified at the head of the ramps which gave access to the wall in rear of the United States Legation. The barricade was erected across this wall on the near side of the bastion. This was a grave error, as the far side should have been selected, but at the time of our occupation we took advantage of a small barricade placed by the Chinese, and worked from that. Later, when the Chinese had occupied and fortified the other side of the bastion, their position was taken from them and turned to our own advantage. Sand bags, or rather bags filled with earth and stone, were found to be of great value during the siege, and the women of the legations were given something to do in making these bags, which helped to divert their minds from the possible results if the Chinese should get in. Materials of all sorts were pressed into service for this purpose, and bags of gaudy satin laid side by side with those of sackcloth.

In the English Legation the best of order prevailed. The civilians were divided into committees, distinguished by different colored badges, and the works of defense, of sanitation and the issuing and care of food supplies went on smoothly under their respective leaders. The Chinese Christians worked faithfully and well under the guidance of their missionary overseers and had it not been for the aid given by these natives in the construction labors, the legations must have fallen.

It soon became apparent that some supreme military authority was needed, and Sir Claude McDonald, at the request of the ministers, assumed this office by common consent of the guard commanders. It then became possible for him to move troops from one point to another as they might be needed.

The besieged stood badly in need of artillery. The Italian 1-pounder did good work until its small store of ammunition was exhausted. The American Colt was found to use too much

of our precious ammunition, so it was sent into the English Legation to be used as a last resort in case of a charge en masse. Necessity being the mother of invention, the "International Gun," now at the Naval Academy, was born. Mr. Squires and Gunner's Mate Mitchell had been experimenting with a "wire-wound gun," the basis of which was to be the cylinder of a pump, when some Chinese unearthed a bronze cannon. It will be recalled that the Russians arrived in Peking with a chest full of 3-inch ammunition, but through an oversight the field piece had been left in Tien Tsin. The shells had been thrown down a well when the siege began to prevent their falling into the Chinese hands. These were now hauled up again and fitted to the bronze cannon. They were found to be too large, so the gun was reamed out by the simple device of pounding a shell home and firing the gun. Needless to say the crew retired before the gun went off. One of the first shots was directed at a blank wall near Mr. Squires' house, who was in some doubt whether the shell would penetrate. It went through the wall and two more besides. The question of a gun carriage was settled by using that belonging to the Italians. The "International" was lashed to a beam and the beam and all pointed. This gun was a sriking example of the Chinese proverb, "Any man can fire a gun, but who can tell where the shot will strike?" It answered its purpose, however, and by shifting it from point to point we sought to make the Chinese believe we were well supplied with artillery.

On the 10th of July the Chinese blew up part of the French Legation and the danger from mining was added to the list of troubles. When relief arrived it was found that part of the English Legation was undermined, and the Chinese had almost completed a mine under our position on the wall.

The Chinese method of building a barricade under fire is deserving of notice. They would tunnel through the houses parallel to the street until a point was reached at which they desired to erect a barricade. If no door was convenient the street wall would be demolished and one or two bricks shoved into place; then one by one the bricks would appear, only the hands of the builders being visible. No matter how many shots were fired at this structure slowly arising before our eyes, the worker would continue to shove his bricks into place. A field piece would, of course, have stopped such work at once, but we had none. Bar-

ricades would spring up in a night, and the morning light would reveal the Chinese positions ten yards nearer than they had been the night before. It was in this way that they advanced down the wall until only the width of the bastion, some 30 yards, separated our lines. Then they built obliquely out into the bastion and began the construction of the tower on our very flank, which is shown in the sketch of the wall barricades. As this tower commanded the inside of our barricade, it became necessary to dislodge them, which was done by a night attack, entirely unexpected by the Chinese, and which resulted in our capture of their position, with a loss of two of our men. Of the Chinese some forty dead were counted the next day. The Chinese having wrested the wall barricades in rear of the German Legation from the Germans, it was necessary to extend our lines to the rear along the wall to cover the water gate. This was done by running a traverse along the outer parapet of the wall, with cross barricades at various places, until a point on the wall was reached some 50 yards beyond the water gate. That position was then held until the relief arrived. After their experience with the night attack the Chinese would fire rockets and burn red fires on their barricades for illuminating purposes. After the truce of July 16 (and it will be noted that this truce was made just three days after their punishment and defeat at Tien Tsin, neither side advanced their barricades, but all hands worked in the strengthening of the defenses already in place. The barricades and bridge heads on Legation Street were reinforced, the bomb-proofs in the English Legation made more secure. The reason for this armistice appeared to have been a desire on the part of the Chinese to persuade the besieged legationers to leave for Tien Tsin, in order that the foreign armies might be stopped in their advance on the capitol. Sir Claude McDonald and the ministers, however, gave politely evasive answers to all suggestions for our departure.

For a while the two opposing forces sat on their respective barricades and exchanged friendly greetings. Proclamations in large Chinese letters hung on our barricades warned away the inquisitive Chinamen from a too close inspection of the strength, or rather weakness, of our defense. It became necessary to shoot a few of the more daring ones before they thoroughly understood that the proclamation meant business. Little by little

the "sniping" began again, and the attack grew in strength as the relief army drew closer to the wall. The most severe attack was on the night of August 14, and the next day the siege was raised.

There were no "military operations" that would justify the name during the siege. It was all a matter of "sitting tight" behind a barricade, constant vigilance night and day, and firing promptly at such of the Chinese as had the temerity to expose themselves. Only once in the experience of the writer did the Chinese leave the shelter of their barricades to make an attack. This occurred on the wall on June 27. A sentry noticed that the Chinese were apparently breaching their barricades, then about 400 yards distant. The field glasses soon showed a number of Chinese issuing from the breach and running along the wall towards us. This movement was made in silence without firing, as they evidently hoped to catch us napping in the heat of the afternoon. We got ready for them and when they were some 200 yards away rose on the banquette and fired over the top of our barricade. They broke and ran back, and not until the last of them had squirmed and wiggled through the tall grass to the safety of their barricades was our fire returned. A few remained lying between the barricades, and their presence, dead, was very disagreeable. The horrors of this phase of the siege are indescribable. The many dead bodies of men, horses and dogs, outside and close to our lines, made breathing at times difficult. Tobacco was not scarce until late in the siege, and its use made life bearable. Most of the dead Chinese between the lines were buried, with our permission, when the truce was declared. It may be believed that this privilege was gladly granted.

Our loopholes were hurriedly constructed and became a source of danger, as the men failed to appreciate the necessity for blocking them up when not actually in use. The Japanese used a small mirror tied to a stick to look through the loopholes, which proved very efficacious in the daytime. The bricks of the Tartar City Wall made excellent barricades, built about four layers thick and breaking the joints. The top was surmounted with double layers of earth-bags, which stopped the projectiles used against us. One bag alone proved inadequate, as Private Toucher, U. S. M. C., met his death relying on one bag to protect his head while firing through a loophole. The bullet was deflected and

must have entered sideways, as his whole forehead was blown in. These barricades crumble on the outside from the hail of projectiles, but were constantly reinforced from the inside. They even withstood the fire from field pieces, judged to be 3-pounders, firing at a distance of some 800 or 900 yards. Bricks in the rear face would be dislodged with some force when the projectiles struck, and caused some discomfort, but the damage was always repaired.

A sentry with glasses kept a lookout on the embrasure where their gun was mounted, and would yell "Shell!" when he saw the flash. All hands would drop into the trench, spoken of before, and lie securely until the shell had either struck or passed over, which latter most of them did. As our position was between two Chinese barricades, they had to be very careful that their guns were well pointed, as it often happened that shells intended for us would sail over our heads and drop among the Chinese beyond us. Thus, although we were between two fires, the position had some advantage.

The American guard was disposed for the most part as follows: About 15 men at the wall barricade, 6 or 7 in the trench communicating with the legation, about 20 at various points in the Legation proper, and 7 or 8 at the barricade on Legation Street. All posts were doubled, allowing one man to sleep and one to watch. At the wall barricade five posts of three men each were maintained, and the entire 15 relieved every night by 15 men from the legation, who were comparatively fresh, as it was possible to wash in the legation. Water for toilet purposes was unknown on the wall.

A table given herewith is of interest in showing the strength of the guards and percentage of casualties. It was compiled by Dr. Velde, a German surgeon, whose excellent work in charge of the legation hospital called forth the greatest praise on all sides. The table is believed to be accurate. The section marked "Peitang" refers to the troops who defended the French Catholic Cathedral. The statement that the Japanese sustained 104 per cent. of casualties is not an error. They defended the "Fu," where the native Christians were herded, and had their work cut out for them from the first. A number of them were wounded, discharged to duty, and wounded again, which accounts for an apparent impossibility.

The question has often been asked, "Why did not the Chinese overwhelm the legation?" It is thought the answer is, first, because their officers do not lead them, and second, because of their superstition. They believed the foreigners to be assisted by spirit soldiers, and hence were afraid to venture too close to the lines which contained, for them, unknown possibilities.

CASUALTIES DURING THE SIEGE OF PEKING.

A.—Legation.

	No. of		Killed and died of wounds.		Wounded.		Casualty in per cent.			Died of Disease.		Volunteers and Independents.		Total.		
	Officers.	Men.	Officers.	Men.	Officers.	Men.	Killed.	Wounded.	Total.	Officers.	Men.	Killed.	Wounded.	Killed.	Wounded.	Remarks.
American.	3	53	..	7	2	8	13.5	17.8	30.3	..	..	..	1	7	11	.....
Austrian .	5	30	1	3	3	8	11.4	31.4	42.8	..	..	..	..	4	11	.....
British ...	3	79	1	2	2	8	3.7	24.4	28.1	..	..	3	6	6	26	.....
French ...	3	45	2	9	..	37	22.9	77.1	100.	..	..	2	6	13	42	.....
German ..	1	50	..	12	..	15	23.5	31.4	54.9	..	..	1[1]	1[1]	13	16	[1] Baron V. Kettler.
Japanese .	1	24	..	5	..	21	20.0	84.0	104.	..	..	5[2]	8	10	29	[2] Mr. Cordes. [3] Incl. Capt. Ands.
Russian ..	2	79	..	4	1	18	4.9	23.9	28.3	..	2	1	1	7	20	[4] Incl. of Cossacks of Legation.
Italian ...	1	28	..	7	1	11	24.1	41.4	65.4	..	..	..	..	7	12	.....
Total ..	19	388	4	49	9	136	13.1	36.6	48.7	..	2	12	23	67	167	

B.—Pei-Tang.

French ...	1	30	1	4	..	8	16.1	35.8	41.9	..	..	..	..	5	8	
Italian ...	1	11	..	6	1	3	50.0	33.3	83.3	..	..	..	..	6	4	
Total ..	2	41	1	10	1	11	25.6	27.9	53.5	..	..	..	..	11	12	

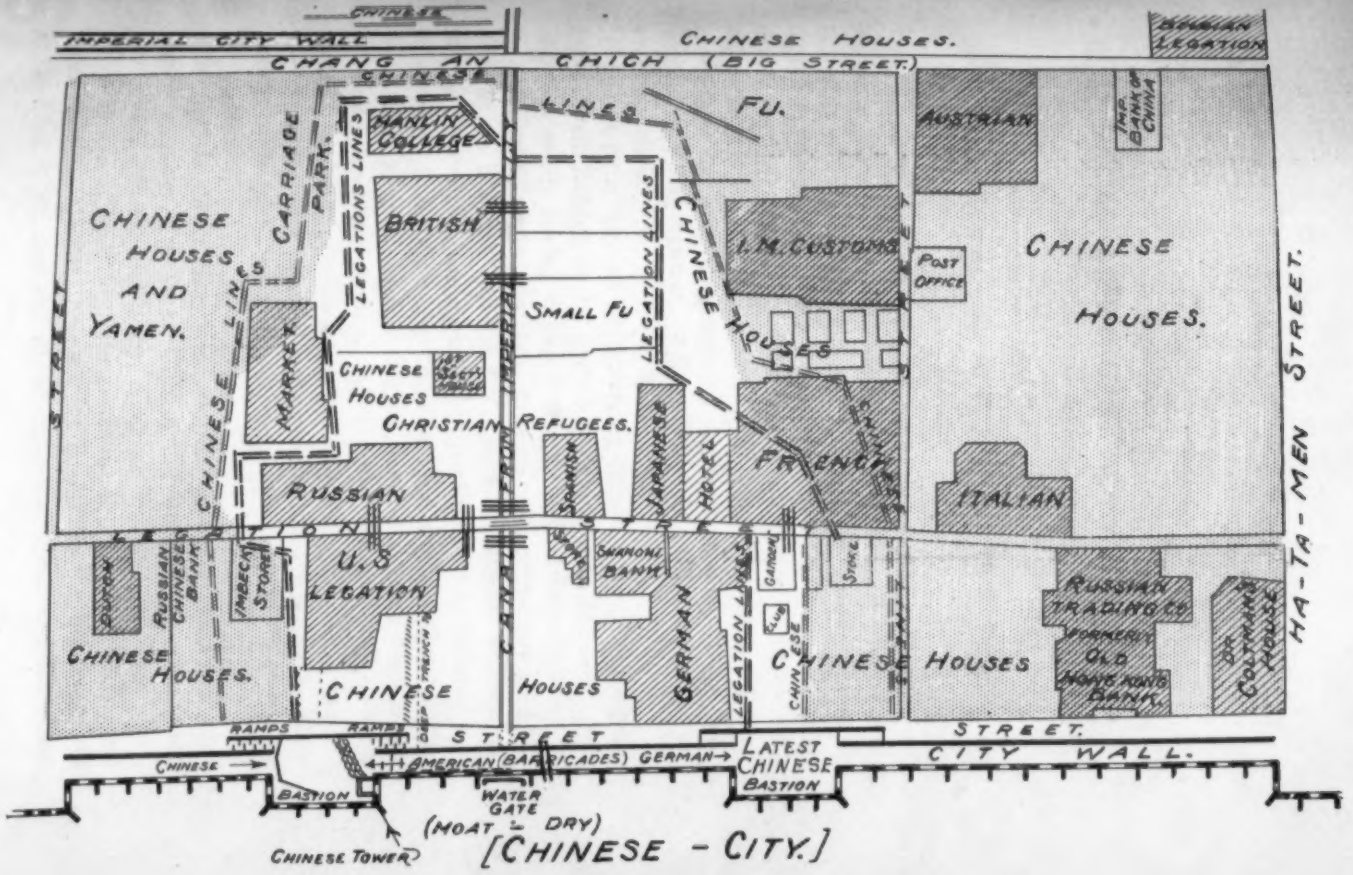
C.—Total.

	21	429	5	59	10	147	14.5	34.9	49.4	..	2	12	23	78	179	

Italian ...	1	11	..	6	1	3	50.0	33.3	83.3	..	..	..	..	6	4
Total ..	2	41	1	10	1	11	25.6	27.9	53.5	..	..	..	..	11	12

C.—TOTAL.

	21	499	5	50	10	147	14.3	34.0	48.1	..	8	13	23	75	170



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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE SIGNAL QUESTION ONCE MORE.

By LIEUT.-COMMANDER A. P. NIBLACK, U. S. Navy.

The navy is again threatened with the periodical upheaval in signals, this time in the shape of a well-defined proposition to abolish everything we have and embark on an experimental code of 44 characters; with a green light added to our four-lamp electric night system; with a white star interjected into the red and green Very pistol code; with a winker light and a flashing search-light for long distances by night; a semaphore by day; and, finally, a flag code of 53 flags using an alphabet instead of a numeral code.

This is a poor time to be upsetting things, even if our signal needs should happen to be pressing—which they are not. We come very nearly having at this moment the best signal system in the world, and I shall later show how we can still further simplify it and make it nearly perfect. To make it almost perfect we may need the wireless telegraph, but perfection may be attained, in the minds of many, by adding the hand and masthead semaphore, such as used in the British navy. On this semaphore question I have my doubts, but I have not the shadow of a doubt as to the proposed system of signals, for it very ingeniously violates every principle of signaling, and wanders directly away from the paths which experience teaches us as the only safe ones to travel.

In 1858 the Myer code was adopted in the army and its inventor, Surgeon A. J. Myer, U. S. Army, was, in 1860, appointed chief signal officer, and went West on Indian campaign duty. Many of the officers and men whom he then instructed and organized into a signal corps went South on the breaking out of the Civil War, and the Myer code was used on both sides.

It was adopted in the navy also, but even in such important operations as those in Mobile Bay, we had army signalmen on board our ships to receive and transmit messages. When Brigadier-General Hazen became chief signal officer, he was instrumental in changing to the Continental Morse code (April 3, 1886), and Brigadier-General Greeley, in Jan., 1890, succeeded in changing to the American Morse code. We followed the army in these changes, but the last one was impracticable, and, after a spirited campaign, the records of which are in the PROCEEDINGS OF THE NAVAL INSTITUTE, the navy, in 1893-94, took up the Myer code again, but so modified as to use only thirty characters for all purposes of signaling. The army later followed us back to the modified Myer and now the code is known as the Army and Navy code. If there is any virtue in both branches of the service having the same code it would seem that the proposed new code might merit consideration by army experts, so that, if we change, the army should also change. This step will however hardly be necessary, because no good reason can be shown for such change.

There is no connection necessarily between a naval battle code of signals and the everyday signal book and signal system, because, while battle signals should be as few and as simple as possible, the methods of transmitting them should be as numerous as practicable. The ordinary signal book and signal codes are simply means of communicating in times of peace, or in time of war up to the opening of fire in a fleet engagement. Battle signals and methods of transmission are a problem in themselves.

In ordinary signaling the hardest problem is in a fog, when the external relations of a ship towards others is most in doubt, but all nations find themselves on a common level in a fog and honors are easy. The fog whistle and gun-fire represent the assets in methods of communication in a fog, and I have always held that the Myer code was peculiarly adapted to this emergency. With a dot-dash code it is necessary to convert it into a 1, 2 code in order to transmit it by gun-fire. On the fog whistle a 1, 2 code is safer than a dot-dash code, because steam whistles are not always reliable in transmitting dashes, and a time element (a distinction as to the *length* of a dot, dash, and

interval respectively) is not so sure as an impulse code (one impulse or two impulses where duration does not enter).

At night the relations of ships to each other are more distinct than in a fog, but we must make sure that our methods are accurate and rapid. The dictum in all signaling is, *that method is best which is most reliable and which is as simple and rapid as is consistent with absolute reliability.* We have for night signaling in squadron:

1. A masthead winker light, visible all around the horizon for the transmission of the Army and Navy code of 30 characters. It is slow because each element in a letter must be made successively. It is not so reliable, because there is usually no repeating back. To do so is to make it very slow. The winker light is practically the sole reliance of the British navy in night signaling for all purposes. We pay far too little attention to it, and have never developed a satisfactory shutter.*

2. A four-lamp night-electric system. By this all the elements of a character are displayed simultaneously, giving rapidity of signaling, and hence, at night, we can signal as rapidly as the British can in the daytime when they use their semaphore. By repeating back at each display, we can get absolute reliability. The signals can be seen *almost* around the horizon. This *almost* is where the defect of the system comes in. With an apparatus forward on one bow and another aft on the opposite quarter, much of the difficulty can be eliminated, but it will be noted that in *important* signals, such as *tactical*, the repeating of one ship gives chances of seeing to others at the moment screened from the flagship's lights. A step in the improvement of the telephotis is the use of the tape recorder for all signals sent or received. The four-lamp system transmits the Army and Navy code of 30 characters with rapidity and reliability. There is no method superior to it, and no more rapid method of communication at sea.

3. The search-light. The Army and Navy code may be transmitted by the wigwag (moving the beam to the right for 1, to the left for 2, and to the "front" for 3) or by flashing it. By actual experiment it has been found that the wigwag gives longer

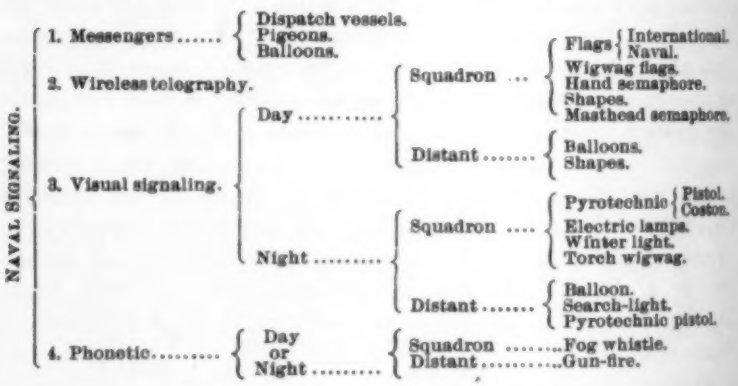
*At sea we cannot use our mast-head winker light because it is used for speed signals, but it is available in port.

range and greater distinctness than by flashing it. Where the light is thrown on the underside of a cloud there is very little choice as to wigwag or flashing. By direct signaling with the wigwag, messages have been transmitted 21 miles at sea at night.

4. The Very's code. With the later type of long-barrel pistol and hermetically sealed brass cases, the range of visibility of the Very's code is about 13 miles. It is slow, but reliable in principle. No other nation has perfected its pyrotechnic signals as we have. I will later suggest a correction of a certain defect which will make the method ideal for its purpose.

I feel justified in claiming that the methods furnished our service of transmitting by night this one code of 30 characters is far and away superior in reliability, in methods, in rapidity, and, above all, in simplicity to those in use in any other navy.

Before taking up the question of day signals, I want to admit that improvement is desirable, but that the proposed substitutes for what we have are the very opposite of what is needed. The following table gives the classification of the different methods of signaling. As previously stated their order of importance is (1) fog, (2) night, and (3) day signaling.



The distinction made between squadron and distant signaling is one of distance, depending upon the state of the atmosphere. Squadron distance is from three to four miles. "Distant" is beyond the limits of squadron signal methods. We have never developed balloons for either day or night signaling. Shapes are pretty much in the air experimentally in all navies. Wireless telegraphy, using the modified Myer code (Army and

Navy), is only a question now of months, or as to *which apparatus* is the best.

In methods of day signaling we have in our service:

1. A flag code of 30 flags (or 31, counting the Church pennant).

2. The hand wigwag flag system.

3. The four-arm semaphore, which under the new Fiske improvements is about to be installed on our ships, having undergone successful experiment and test in the North Atlantic Squadron.

On the question of flag hoists for signaling, it would seem that wireless telegraphy might decrease their use, but they will never be displaced. Of this I feel sure. Flags possess the great advantage that in one hoist three or four elements can be displayed at once, and for general signal purposes thousands of permutations and combinations can be made. The objections to the use of flags are that in a calm they hang limp; in an unfavorable breeze they fly edge on; in haze and smoke the colors cannot be distinguished; the colors get dull and soiled through various causes; and finally, in action, halliards are very likely to get shot away. The greater the number of flags in a hoist the greater the chance of making a mistake in reading the signal; also the longer it takes to bend on and hoist a signal. The simpler or fewer the colors in a flag the less liability to make a mistake in reading it. The smaller the flags the quicker they can be handled, but the more limited the range of visibility. Mathematically the more flags you have in a code the greater the chance of error in reading a given signal.

My proposition is to reduce the number of flags we have, but the proposed scheme is to increase the number to 53. We can best understand both propositions by a brief glance at foreign methods.

The British navy uses 58 flags, and they have five flag hoists (four repeaters) and two separate signal books. It will always be noted that British ships, while using the day semaphore with dazzling rapidity, are much given to enormous displays of bunting in flag hoist signaling, and that too quite often in conjunction with semaphore messages.

The French navy uses 51 flags, and has three numeral codes. The shape of the uppermost flag indicates which code is used.

The German navy uses 43 flags, principally letters of the international code but with different significations. As their night code is a numeral one their signal book is indexed both for letters and for numerals.

We come next in that we use 31 flags, which I suggest we reduce to 29 or 28.

The Italian navy uses 26 flags of the international code, but with special significations, and their signal book is alphabetical.

The Austrian navy uses 24 flags which have both a numeral and alphabetical signification. They use a very clever trick whereby, limiting to four flags in a hoist, they increase indefinitely their number of four-flag hoists. It is this system that I shall propose we adopt, and thus simplify and renovate our entire system of signaling.

The Danish navy uses 22 flags. They have 22 sets of halliards, and they hoist each flag separately, but in the right (relative) position.

An analysis of our signal book and flags will show, that, with a numeral code we are limited to 9999 signals, using a four-flag hoist as a limit, or using the 0 in first place we can add another thousand (0999) so that we can just about touch the 11000 mark (10,999).

In the general signals we utilize only 5856 numbers. In the telegraphic dictionary we use 10,999, or, in other words, the full allowance, and more could be used if available. The Geographical list uses 7280, and we could use several thousand numbers for a "Navy list" of officers.

The avowed object of the proposed code of 53 flags is to give us an alphabetical instead of a numeral code, thereby giving us fewer flags in a hoist and increasing the number of signals possible. According to the scheme, tactical signals are to be two flag hoists, other general signals are to be three flags, and telegraphic and geographical, four flags. One fallacy in this is that with 10 numerals and 3 repeaters or 13 flags in all, it saves no more time to pick 3 flags out of 13 or 4 out of 13, than it does to pick a 3- or 4-flag hoist out of 26 flags—and the chances of mistake in reading are mathematically greater. As stated, we use only 5858 signal numbers in our general signals, and yet we might use 10,999, and we would use more than 10,999 in our telegraphic dictionary if they were available.

We have ten numerals and three repeaters. That makes thirteen. We have five flags with more than one meaning, viz., cornet, answering pennant, numeral pennant, despatch flag, and convoy flag. That makes eighteen. We have thirteen flags with only one signification, viz., guard, position, general recall, church pennant, danger, annulling, negative, affirmative, preparatory, interrogatory, quarantine, compass, and telegraph. That makes thirty-one in all. Using the Austrian trick of four-flag hoists, let us take the general recall flag. Hoisted alone it has only one meaning. Let us use it in the first place in a hoist to represent twelve thousand; in second place to represent thirteen thousand; in third place to represent fourteen thousand; and the bottom flag in the hoist to represent fifteen thousand. Thus: General Recall 987 = 12,987, or 9 General Recall 87 = 13,987, or 98 General Recall 7 = 14,987 and 987 General Recall = 15,987. Similarly, without danger of confusion, we could use the convoy flag for sixteen, seventeen, eighteen and nineteen thousand; the despatch flag for twenty, twenty-one, twenty-two and twenty-three thousand and the church pennant for twenty-four, twenty-five, twenty-six and twenty-seven thousand. The position pennant could be used as a substitute for any of the above or else to carry the numbers up to 31,999, or practically 32,000. We actually use 24,137 numbers now, or adding the navy list we would have a total of about 26,000 now demanded.

The great advantages of the above method are: 1st. It would do away with the double stars in the telegraphic, geographic, and navy list calls of the Very code and remove a great drawback which the code has by its use of the old bracket. 2d. It would enable us to start our signal book at 0 or 1 and run up indefinitely without the use of a code call. All signals would thus be general. 3d. We could do away with the telegraph flag and the compass flag. Compass signals would simply be in degrees from 1 to 360° from north around to north again by way of east, south, and west. The signal book should give the conversion of degrees into nearest quarter points for each of the 360 degrees.

There is another reform which I would propose in our flag code while we are about it, but it is not important enough to insist on. In the modified Myer (Army and Navy code) for all purposes of signaling we have p = affirmative, k = negative,

q = interrogatory, and w = annul. Just for consistency I would like to see the corresponding (letter) flags of the international code used in place of the affirmative, negative, interrogatory and annulling pennants now used. It would enable us to use the quarantine flag (international q) for interrogatory, thus reducing our total flags to 28. I do not insist on my hobby of the modified Myer being dragged into the flag business—but simplicity would be served thereby—and the modified Myer is the best signal code in the world.

In the light of the immense relief it would give to our code to simplify it by getting rid of the telegraphic, geographical, and navy list troubles, it is appalling to think of deliberately hanging a millstone around our necks by adopting a 53-flag code, not even considering the violence done to the Very code by the use of a third colored star, and to the electric lamp system by the addition of a green one.

It is indefensible to use a green transmitted light for signal purposes. A green light is always, or nearly always, white at long ranges (as is also a chemical green star) and the net result of the addition of either the new white star or green lamp would be to reduce the range of certain visibility or reliability of two of our splendid night codes.

The new proposed code uses groups of 1, 2 and 3 and thus succeeds in getting more than 30 permutations and combinations. Each flag of 44 out of the total 53 has a group of characters using one, two or three dots to represent it by flashes of light, or toots on the fog whistle, etc. Thus on the fog whistle the "recall" would be . . . . . or 12 toots. With the Army and Navy code the maximum is the letter z = ... or 8 toots. It is difficult to patiently point out the one after another indefensible departures of the proposed system from the virtues of our present methods using the Army and Navy code.

To flash a message by search-light is not so distinct nor so visible at long distances as to wigwag the beam, yet we must give up the latter because the new code is to be a three-element code that cannot be wigwagged.

This system or proposed code which I have been criticising in this article is now under consideration at the War College

but is not in one sense a product of that institution. As the scheme is soon to be submitted to the Navy Department, I hope to get a hearing officially and to point out that it is exactly in every particular just what the navy neither wants nor needs.

Many people in our navy favor the hand flag semaphore; and even the masthead semaphore for rapid day signaling. Naturally it is quicker than the wigwag because it displays each character instantaneously, while the wigwag must make the elements successively, just as at night our four-lamp system shows the entire character in one display while the winker light must display the elements successively. My only objection to the semaphore is that it adds another *code* to our burdens. We have now simply a flag code, and the modified Myer. The latter we transmit by wigwag flag, lantern, torch, or search-light beam, by winker light, by gun-fire, fog whistle, or Very's pistol, or by semaphore arms or red and white lanterns. W is always the annulling, x is numerals, p is affirmative, k is negative, and q is interrogatory no matter what method we use.

The Department has at last yielded to the wish for a hand semaphore and asked for a trial and report in the various squadrons. It is unfortunate that there are only 28 characters in the British code, or in any two-arm code. For in our code we need thirty. Therefore, to use the British two-arm code (to assimilate it to the Myer code) it becomes necessary to use U for the interval and to give to P the signification of numeral 3, in addition to meaning "affirmative." In other words, if we could invent two additional positions of two arms other than used by the British we could make the semaphore code correspond letter for letter with our use of the Myer, and thus in a measure assimilate it.

For my part, as we have the four-arm semaphore mounted on many of our ships, and have a satisfactory mechanical method of working it, I prefer in the light of the promised developments in wireless telegraphy not to add the British semaphore to our burdens. I have seen the wigwag flag used like lightning. We really don't need the British semaphore. There is now too much fruitless signaling of wigwag messages that

were better if not sent, and better sent by flag hoist for drill purposes, if of importance.

Anybody can *send* signals. The success of a system is tested at the receiving end. We admire the British smartness. With one of their flagships carrying some thirty-five in the signal staff, the test of efficiency is the poor harassed auxiliary or destroyer trying to catch a lot of smartly delivered signals. The annual British manœuvres show this. Our methods are much safer. We refuse to rate people for signal expertness. We demand that every line officer and every enlisted man in the deck force shall absorb all the signaling he is capable of. Experts develop naturally, but the dullest person, if he can read and spell, can make some headway, but it obliges us to keep our system as simple as possible. When I hear officers compare our signaling unfavorably with foreign ships I sometimes think our ships vary in efficiency as the commanding and other officers vary. Every nation has its problems. With our intelligent personnel I would rather follow our simple methods than to be restlessly wanting to adopt foreign methods merely because we don't use what we have. Practice can alone make perfect. We are on safe ground in signaling, I feel convinced. Let us stay there. I am only led to propose the changes in our flag code because of my liking for the Very pistol code which Lieutenant-Commander R. T. Mulligan did so much to develop and perfect. I would like to see the bracket stars for code calls in the Very done away with, and the solution is simplicity itself.

What is everybody's business is nobody's business. Signaling sort of shifts for itself, but while I live I shall never cease to raise my voice and wield my pen against this running after false gods in signaling. I am sort of sponsor for the modified Myer code. You can do anything with it. If we are to have a hand semaphore system its alphabet should be given the same signification as in this code. If wireless telegraphy is coming in it must use this code. It is planned to use a dot-dash code, but if that is *essential* to its transmission then we can call our 1 a dot and our 2 a dash, but we will not take back the Continental Morse code. Any system which can be adapted to the Army and Navy code and insists on keeping its own should

get short shrift. Simplicity, reliability, and as great rapidity as is consistent therewith. Let us tie down to this. It is astonishing what a little practice in signaling will do for ships. More of them ought to try it, and we would hear less about foreign signal systems, which are based on expertness *in spite* of methods inferior to our own. We have the best code in the world and let us realize it and live up to it.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

SOME EXPERIENCES ON BOARD THE U. S. S. MANILA.

By LIEUT.-COMMANDER W. F. HALSEY, U. S. Navy.

Among the captures made by Admiral Dewey, on May 1, 1898, was the Spanish armed transport Manila. This vessel, built in Scotland in 1880, was, shortly after being captured, placed in commission as a gunboat in the United States Navy; was classed as a third rate with a given displacement of 1,900 tons, and under several commanding officers did excellent work in the Philippines. The hull of the Manila is of iron; length, 208 feet; beam, 32 feet; engine compound of the English inverted type, I. H. P. 740; mean draft, 14 feet; speed about 10 knots. Extensive repairs necessitated the return of the Manila to Cavite in October, 1900, and from that date until the departure for the United States (April 15, 1902) the vessel did little cruising; as a matter of fact, owing to the existing doubt of seaworthiness, the Manila was not sent out of the bay for a year, the duties performed being those of station or receiving ship.

Certain repairs having been effected, preparations were made for a trip to Bremerton, via Guam and Honolulu, the route via Yokohama having been changed, at a late date, to carry stores, brought by the Rainbow for Guam.

An impression had prevailed that 800 tons of coal could be stowed in the ship, and in order that the draft might not be abnormally increased, 100 tons of ballast were removed. On April 15 the Manila sailed from Cavite, the total number of persons on board being 201. It was found that not more than 450 tons of coal could be taken, but with this, and three months' provisions, and all available tanks filled with fresh water, the ship was deeply laden.

Probably for twenty years the Manila had not seen a sea horizon for more than 24 hours in succession. None of the officers had any experience with the vessel; the records were incomplete, and as to what would be the performance of ship and engines in a sea way no man could say. The inside run to San Bernardino Straits was uneventful, there being nothing to test the weatherly quality of the vessel, but the experience showed an unexpectedly large expenditure of coal for miles made good. From San Bernardino to Guam a fresh monsoon, or more properly N. E. trade was met; the seas were long and the Manila short; as a natural consequence, with a head wind and sea, the deck was flooded for a week. The seas taken over the bow would be broken by the windlass and steel houses forward, but the mass of water would sweep aft, frequently meeting a wave that had been dragged over the stern. The experience of taking seas over both ends at the same time was a new one. The steering gear proved to be very unsatisfactory. On the lower bridge was situated the pilot house and forward steering wheel; the latter was heavily cogged, and over a sprocket on the barrel ran a chain; this chain, after passing down the superstructure, was connected to rods in the waterways, the rods being, in turn, connected with the rudder by a quadrant on the rudder post. The after-wheel worked a double screw, which, by means of a yoke on the rudder post, actuated the rudder. Neither of these wheels was provided with steam gearing. Four times the chains parted, and the forward gear was considered so unreliable that, on the high sea, the vessel was steered by the after-wheel. For over 6,000 miles this wheel was used, the quartermaster and helmsman being out of sight of the officer of the deck. For the use of the man at the wheel a condemned boat compass (the best on board) was mounted on a small tripod and was lighted at night by an ordinary ship's deck lantern. The course was checked by the standard compass, and the resulting landfalls were excellent. The Manila anchored in the harbor of San Luis d'Apra at 9.30 p. m., April 23, having taken eight days and sixteen hours for the run of 1,500 miles. The coal supply at Guam was limited, and only 105 tons were obtained to replace the 150 expended.

Immediately on leaving Guam the heavy seas and fresh winds of the N. E. trades were encountered and the experiences of the

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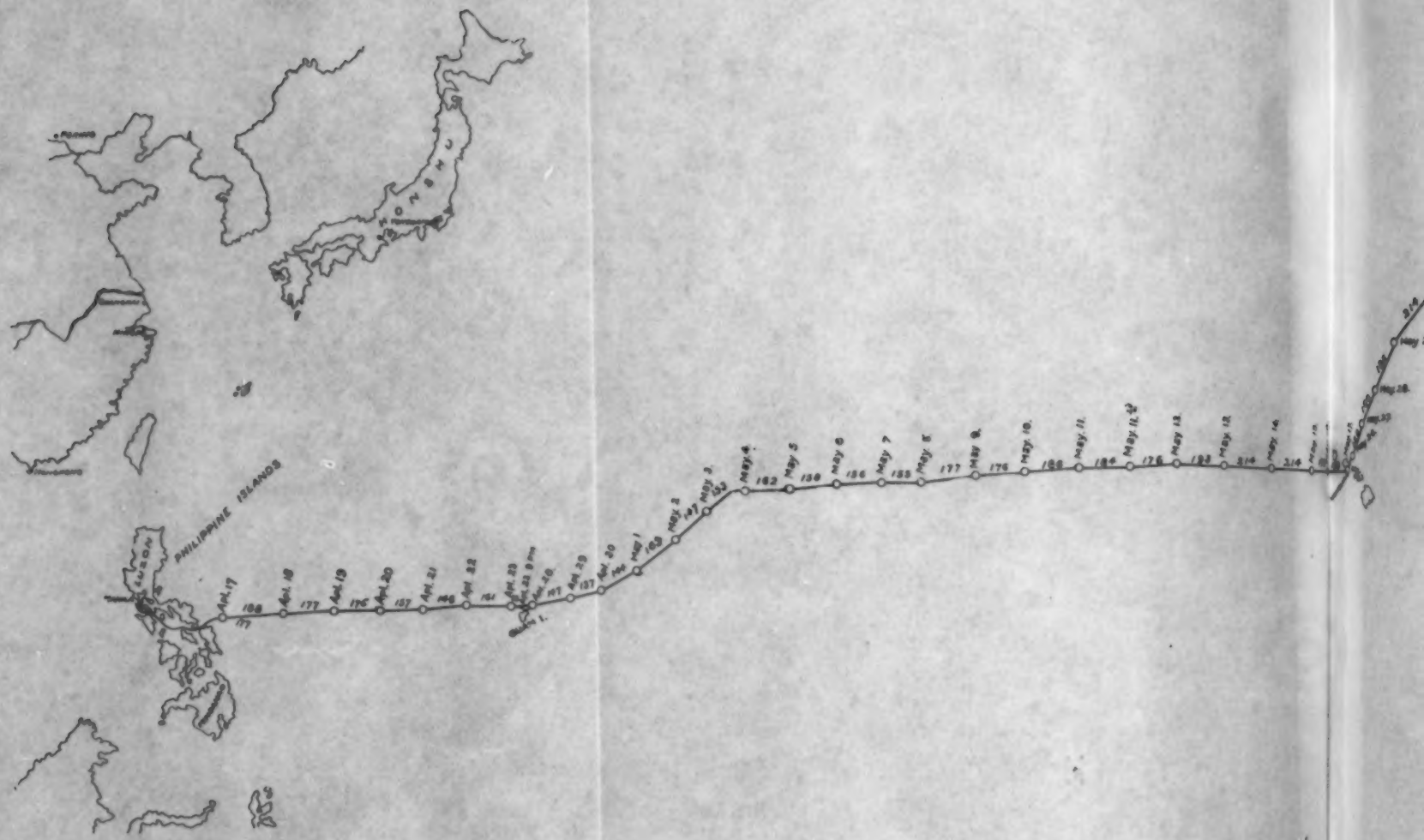
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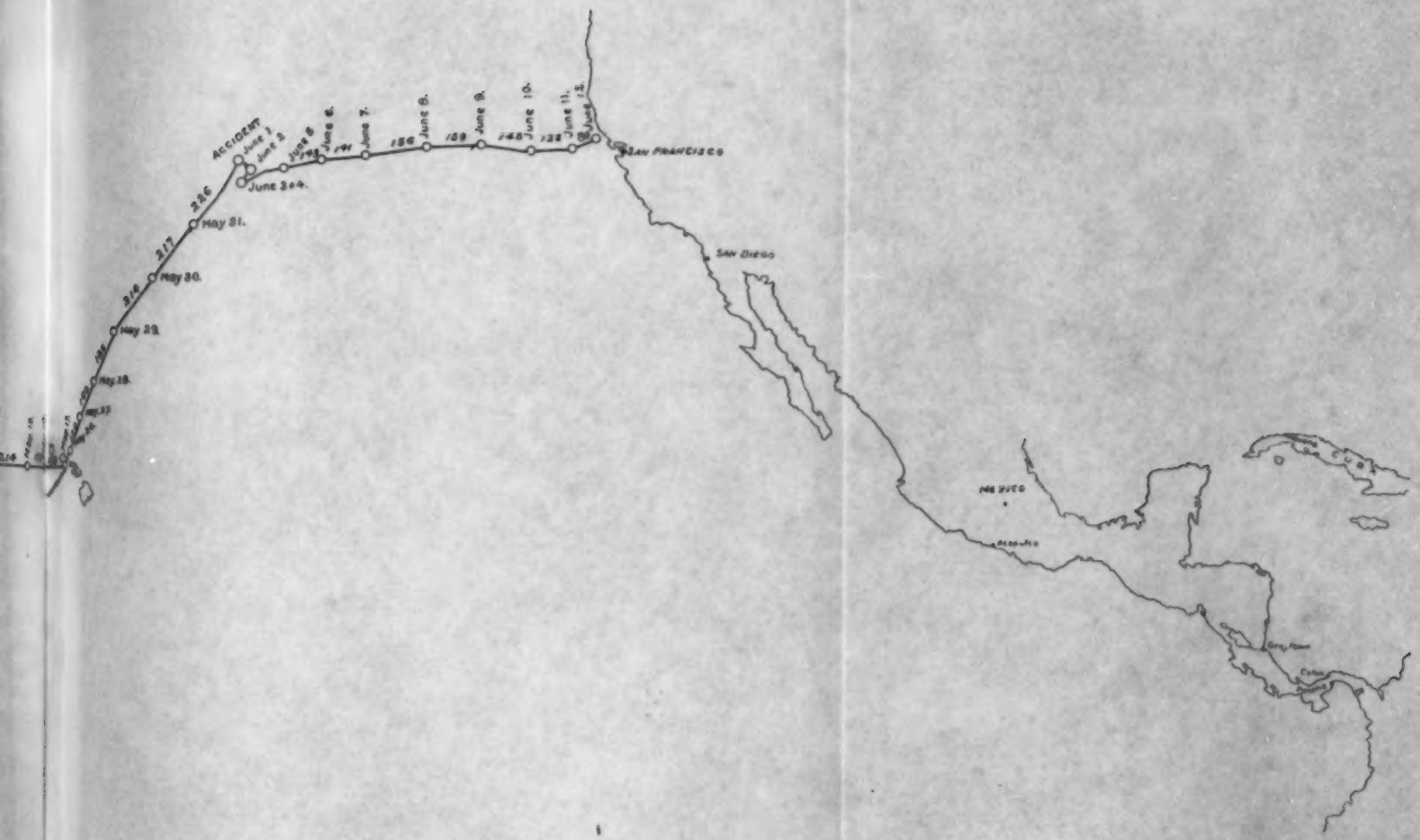
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run from San Bernardino were repeated. The chart published by the Hydrographic Office for the guidance of steamers gives a short route from Guam to Honolulu, the route offering an opportunity to report on the many doubtful dangers that for years have been carried on the charts of this part of the Pacific. This route the Manila was directed to follow, but unfortunately it lies in the strength of the trades, and after having the daily run reduced to 137 miles, with an expenditure of 17 tons of coal, it became apparent that, unless better progress was made, Honolulu would be distant about 600 miles when the coal would be expended. In deciding upon the route to be taken, the information furnished by the pilot chart of the North Pacific Ocean was followed. The accuracy of this publication is remarkable. A course was set to the Nd. until the region of light trades was reached, when with correspondingly moderated seas better results were obtained, and the easting made with less coal expenditure. The run from Guam to Honolulu, about 3400 miles, was made in a little over 20 days, and was most trying. The vessel was never quiet for an instant, and combined more movements, at the same time, than had ever been observed on any other vessel during a service of many years at sea. The pin holding the yoke on the rudder post worked loose, and it became necessary to dismount the yoke. Probably this yoke had never been disturbed since the vessel was built, for it took all the obtainable hydraulic jacks and 14 hours of work to complete the operation; adding to this the fact of a lively moving and jumping vessel, it can be appreciated that the difficulties were not small. During the run from Cavite the wind had been practically ahead, so that the fore and aft sails had not been set for 24 hours of the 28 days at sea.

At Honolulu a careful overhauling and testing of all the machinery occupied the attention of the engineer officer, and on May 26 a start was made for Bremerton, following the great circle route from Honolulu to Juan de Fuca Straits. For two days there was the usual struggle with the trades, but having passed their limits the progress was more satisfactory. On June 1 the Manila had made the best day's run (227 miles) since leaving Cavite. The conditions were excellent—sea smooth, light favorable breeze and a cool temperature that was most bracing after the long stay in the tropics. At 2.45 p. m., without any

warning, ship steaming 9 knots, several of the dependencies of the high-pressure engine were wrecked and the main engines ceased to operate. When an examination could be made, it was found that the high-pressure piston was in fragments. The initial point of rupture appeared to be a small sand hole from which a crack radiated to the circumference of the piston (diameter 32 inches); the other side of the cracked piece showed the threaded hole of a core-hole plug. The piece and plug being released, were drawn through the port into the valve chest, and meeting the high-pressure valve on the up-stroke, caused irreparable damage. The broken fragments of the remainder of the piston fell to the bottom of the cylinder, and being brought upon by the hub tore away the bull ring that formed the stuffing box for the high-pressure piston rod. Through the hole thus made live steam and much debris entered the engine room. The final stroke bent the tail rod twice, cracked the inner liner of the high-pressure cylinder and carried away the go-ahead shoe. The wreck was complete in detail, but fortunately, owing to the prompt action of the machinist on watch, steam was shut off and no one was injured. Every attempt to run as a single engine failed up to midnight of June 3. It was impossible to get the piston to pass the centre; the engine was jacked until the piston was at the top of the stroke; steam was given at the critical moment, but without success. It was determined, as a last resort, to change the eccentrics to allow the steam to follow full stroke. For three days the work of the engineer's department was excessive; with but a limited time for meals they were engaged until midnight and began work at 4 a. m. At the time of the accident the Manila was 1,200 miles from Honolulu and midway between Juan de Fuca and San Francisco, each distant 1,100 miles. The great circle course followed had placed the vessel outside all tracks for sailing or steam vessels, so assistance from that source seemed remote. Of the seven boats carried only two could be of any use for a relief expedition. This subject was carefully considered, and there were many volunteers by the officers, but it was not deemed advisable to begin work on the boats until all attempt to start the engine had failed. The Manila was provided with four staysails and two trysails. These were set. From the afternoon of June 1 the barometer had begun to fall steadily, with an increasing breeze from S. E. On June 3 it

was blowing a moderate breeze with the ship 16 points off the course. No disposition of sail or helm would cause the vessel either to come up or fall off; the sea directly abeam began to cause apprehension. At 5.30 a. m., June 4, it was blowing a moderate gale from the S. E., with a heavy sea; got over a sea anchor, and the main trysail having been carried away, lashed heavy canvas to the rail and ridge rope on quarter to keep vessel up; used oil bags and furled the remnants of the sails. The deep and quick rolling of the vessel added to the difficulties of the work in the engine room. The engines of the Manila are massive; the valve of the low-pressure engine weighs 3,000 pounds. At 11 a. m. the barometer fell with a jump and the gale was at its height; force of wind in squalls from 8 to 10, with a cold driving rain; sea tremendous. Until 2.45 p. m. the vessel was in the trough of the sea absolutely without control. The after deck-house, in which were situated the quarters of the commanding, executive and navigating officers, and officers' messroom, was of wood, very old and badly eaten by ants. It was feared that a sea coming on board would carry away this house and cause the vessel to fill aft. The wardroom was flooded by the water that came through the open deck seams. Owing to the limited capacity of the bunkers, it had become necessary to carry coal in the holds, and by this means a list had been given the ship. An unfortunate construction had placed under the wardroom a large feed water tank that extended well outboard; this tank, without any fore and aft partition, had a capacity of 80 tons, and when not filled the water naturally ran down hill. The list caused by coal and water was to leeward. The clinometer was graduated to 37½°; at this point the pendulum brought up against a stop; as the pendulum rested against this stop at each roll, the amount of inclination can be only conjectured. At times it seemed impossible for the vessel to recover from the roll quickly enough to prevent the rapidly recurring seas from being taken on board. Fortunately, the Manila possessed one good quality—marked stability, which, with the rapidity of the rolls, brought some comfort to those on board. At 2.45 the engine, probably assisted by the action of a wave on the propeller, started with a jump. At this time the steering gear again became deranged. Way was gotten on the ship, and not being controlled by the helm, the vessel turned and brought the sea aft, a situation if possible

more dangerous than the previous one. As soon as the steering gear would work the vessel was brought up against wind and sea, with the latter on the bow, and remained in that position all night with the engine making about 40 turns. The gale moderated rapidly and observations showed San Francisco, distant 1,100 miles, to be the nearest point. As soon as the state of the sea permitted a course was set for that port. Until June 11 the Manila proceeded under one cylinder, making about 150 miles daily. A balanced compound engine when disconnected and run as a single engine is not desirable. There was always a doubt as to whether or not the piston would stick on the centre, and the groaning and complaining of the several parts told of the unusual strains brought on the machinery. Had the low-pressure engine failed, the sole recourse would have been a long and dangerous boat expedition for aid. During the three days when helpless the Manila had drifted in three different directions, averaging between 50 and 60 miles a day; had the boat expedition been a success, where would the rescuing party have looked for the Manila?

On June 11 it began to blow hard from N. W. and the vessel was run until the quantity of water shipped and the excessive complaining of the engine made it necessary to bring the ship with wind and sea on the bow. The engine could not be stopped, neither could the number of turns be increased nor reduced. Observations on June 12 placed the vessel to the Nd. and Wd. of Point Reyes, Cal., with a moderate N.W. gale blowing, with a heavy sea. It was determined that the conditions justified an attempt to be made to run before the sea, though it was not known how the vessel would behave under this condition. Fortunately, good weather was made, and under steam and the remnants of the sails a speed of eight knots was obtained.

Passing Point Reyes light, the vessel's number was made, and the breaking of the high-pressure piston was signaled. Fifteen miles from San Francisco the large wrecking tug Relief offered assistance, but this was declined, as it was thought port could be made without aid. Following the Relief came the army transport tug Slocum. The latter vessel kindly stood by and just before reaching the Golden Gate imparted the information that the ebb tide was making at the rate of 5 knots an hour. At this time the Manila was making 5½ knots, so it was deemed ad-

visable to send a line to the Slocum. This was done without stopping the engines of either vessel. On letting go the line the Manila's engine was stopped on signal, but all attempts failed to either back or again start ahead. After steaming for 1,100 miles with one cylinder the engines could not be operated, and with a feeling of great relief and gratitude the anchor was let go in the harbor of San Francisco.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

GRAPHIC SOLUTION IN COAST NAVIGATION.

By LIEUT.-COMMANDER H. S. KNAPP, U. S. Navy.

In No. 4, 1900, Proceedings of the United States Naval Institute, is described a valuable instrument for the graphic solution of plane triangles devised by Capt. Allan H. Porter for the particular purpose of finding the position in coast navigation. As far as is known to the writer, such instruments are not furnished naval ships, and to make the necessary triple parallel rulers accurately with a ship's appliances might deter officers from an attempt to use the principle of the graphic method. Everything needed for the graphic solution is, however, either now furnished or can readily be made on board ship. A protractor, the cross-section paper marked in tenths furnished to navigators, thumb tacks, a chart board and a ruler are all that is required. It may be found convenient to make a special long ruler with a strip of the cross-section paper pasted on the bevel close to the edge and somewhere near the middle of the length.

In submitting this and what follows nothing particularly new or original is claimed. Simply a very convenient graphic method is pointed out, for which everything is at hand, and by which the information sought can be obtained without computation or the use of tables and can be preserved for comparison with later observations. This graphic comparison is a valuable feature, appealing at once to the eye. No expectation is entertained that navigators will use the method in place of the quick mental process for finding the distance by the bow and beam bearing. With other bearings, however, and particularly in view of the ease and rapidity with which it can be used, and the fact that each record is preserved, the method is believed worthy of trial.

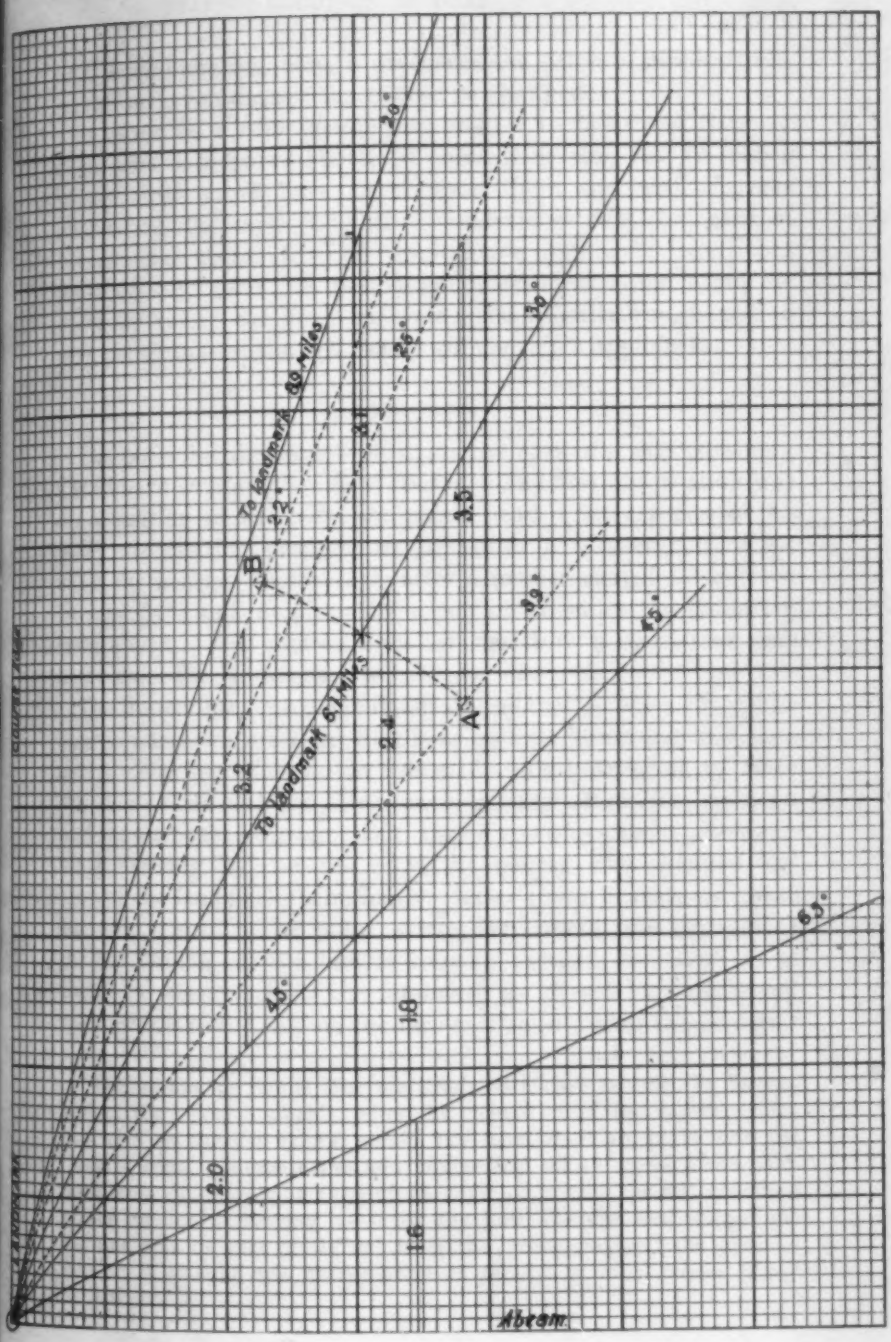
On the cross-section paper assume the position of the land-

mark at a corner origin of the ruled lines, and assume the course parallel to one edge, which may be called, to distinguish it, the "course edge." As an instance, suppose the landmark first observed when bearing 20° off the bow; from the landmark rule a line making an angle of 20° with the "course edge." After running a distance of 3.1 miles suppose the landmark to bear 30° off the bow; rule a second line making an angle at the landmark of 30° with the "course edge." Move the ruler parallel to the "course edge" until the distance run, 3.1 miles, is just included between the two lines of bearings and rule a line between the two. The distance from the landmark that the ship will pass when abeam, supposing no drift, is seen by inspection before raising the ruler if the latter be long enough to reach the ruled line passing perpendicular to the "course edge" through the landmark. The distance on either bearing from the landmark is found by measuring with the ruler. Practical parallelism with the "course edge" in fitting the distance run between the lines of bearing is easily attained because of the multiplicity of ruled lines.

Drift, either toward or from the landmark, will be detected if continuous observations be made, and the lines be ruled each time to represent the distances run between the several bearings.

Further, suppose the course be changed before reaching the bearing on which it was intended to make the second, or a later, observation; the drift can still be detected if one bearing and the attendant patent log have been noted. Read the patent log just before the change; the new bearing will be found near enough in the great majority of cases by applying the number of degrees change of course to the bearing just before the turn. Neglecting the transfer in turning, the *distance* from the landmark just after the change is the same as just before it. If the new bearing be ruled off and that distance from the landmark be marked upon it, drift will be shown at the next observation if the line representing the run between does not pass through the point marked.

The bow and beam or beam and quarter bearing is naturally the particular case of this problem most in use, but circumstances not infrequently arise under which it cannot be used, particularly when the course is changed between. The graphic solution obviates the necessity of waiting for *any* particular bearing,


29°
30°
26°
22°
To landmark 69 miles
To landmark 61 miles
A
B
3.5
3.2
2.4
45°
63°
2.0
1.6
Abeam

and, if used continuously, it preserves the value of previous observations, even though the course be changed.

It would be a very inexpensive matter to print and issue to ships special prepared sheets of convenient size, say 12 inches square, with cross lines ruled upon them and with degrees marked on the edges (or with a quadrant drawn from each of two adjacent corners). This would leave nothing to handle but the sheet and ruler. A permanent instrument could easily be made by ruling the lines on plate glass slightly roughened to take pencil marks, though hardly with a ship's appliances.

Examples.

The plain line figure will illustrate the case of a ship passing a a landmark without change of course. The first observation was on a bearing of 20° from the ship's head. After a run of 3.1 miles the bearing changed to 30°; after a further run of 2.4 miles the bearing became 45°; after a further run of 1.8 miles it became 65°; and, finally, after a run of 1.6 miles the landmark bore abeam. The plotted lines for run show a consistent drift away from the landmark.

The dotted line figure will illustrate the case where a change of course was made after the first bearing and patent log had been noted. The first observation was made on a bearing of 25° from the ship's head with the intention of getting a bow bearing next, and then a beam bearing. But, after a run of 3.5 miles, the landmark bearing 39° on the bow, the course was changed 17° toward the landmark, bringing the latter's new bearing 22° from the ship's head. The point where the course was changed is at *A*. Laying off the line of bearing for 22°, the point *B*, at the same distance from the landmark as *A*, will now represent the position of the ship on the new course just after the change.*

*The reason for this is that the course is always assumed to be parallel to the "course edge." After the change at *A*, the course, which had been so parallel before, would run from *A* at an angle with the "course edge." Suppose the new course laid off 17° toward the landmark from *A*. Revolving through an angle of 17° the system consisting of the *old* line of bearing 39° from the bow and the *new* course, the old line falls on that drawn 22° from the "course edge," the point *A* falls on *B*, and the new course becomes parallel to the "course edge," as it should.

After a further run of 3.2 miles the bearing was brought off the bow, and the plotted run, not passing though *B* but nearer the "course edge," showed an apparent drift toward the landmark. This drift was confirmed when the landmark came abeam after a run of 2 miles.

NOTE.—My idea of the cross-ruled paper seems to have been adopted in principle by Lieut.-Commander J. B. Blish as far back as 1897 in an instrument devised for the same purpose. The form of his instrument, however, is different, and I am unconscious of ever having seen or heard of Mr. Blish's instrument, which was described in Commander Tanner's report of the cruise of the Albatross, 1897, until my attention was brought to it.—The Author.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

METHODS FOR FINDING THE INTERSECTION OF TWO SUMNER LINES.

(1) GRAPHICALLY. (2) BY TRAVERSE TABLE AND TABLE FOR DISTANCE OF AN OBJECT BY TWO BEARINGS (TABLES 2 AND 5 B, BOWDITCH). (3) BY TRAVERSE TABLE ONLY (TABLE 2).

Suggested by LIEUTENANT G. W. LOGAN, U. S. Navy.

Graphic method.—Navigators have found some inconvenience in plotting Sumner lines in the way usually recommended, namely, on a chart of the ship's locality or one of the same latitude; first, because such a chart on a sufficiently large scale is not always at hand; second, because such a use of the chart rapidly wears it out; and third, because all officers aboard ship who have to work out the ship's position have not the facilities in their quarters for spreading out a good-sized chart and working upon it with parallel rulers.

To obviate these disadvantages, the method here given enables the plotting to be done graphically upon a small-sized sheet of paper and with an ordinary ruler.

Suppose that the lines are defined by the latitude and longitude of two points of each; that is, for example, that, in working time sights, two latitudes have been assumed and the longitude found corresponding to each.

Now consider that these lines are plotted on a chart which is constructed upon a sheet of elastic rubber. It is evident that if, while holding it fast in the direction of the meridians, we stretch this rubber along the lines of the parallels in a uniform manner until the length of each minute of longitude is made to equal a minute of latitude, the chart, while losing its accuracy as portraying actual conditions on the earth's surface, still cor-

rectly represents the positions of the various points in terms of the new coordinates which have been created, namely, those in which a minute of latitude is equal to a minute of longitude. Thus, if on the true chart a point is m minutes north and n minutes east of another, on the stretched one it will still be m minutes north and n minutes east, the only difference being that the minutes of longitude will now be of a different length; and if on the original chart the two Sumner lines intersect at a point m minutes north and n minutes east (on the original scale) of some definite point of one of the lines, the intersection on the stretched chart will lie m minutes north and n minutes (of the new scale) to the east of the same point.

A stricter mathematical conception of the stretched chart and its properties may perhaps be obtained by considering the chart of the locality to be projected (with the eye at the zenith) upon a plane passing through one of the meridians and making an angle with the plane of the horizon which is equal to the latitude; each minute of longitude will then be increased by multiplying it by the secant of the latitude, and thus become equal to a minute of latitude.

A consideration of the properties of this hypothetical chart enables us to lay down the following rule:

If two or more Sumner lines be plotted by their latitude and longitude upon any sheet of paper, using a scale whereon latitude and longitude are equal regardless of the latitude of the locality, the intersection of those lines, measured by coordinates on the scale employed, correctly represents the intersection of the lines as it would be measured upon a true chart.

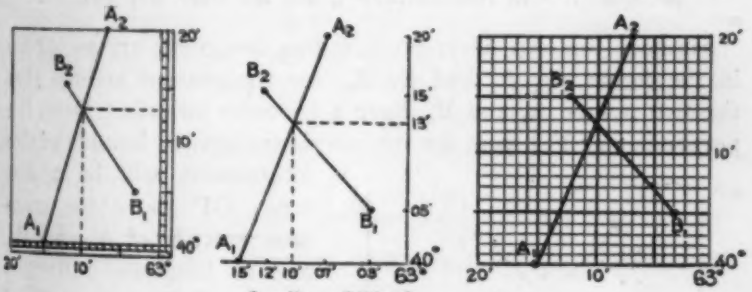
It follows from this that we may plot Sumner lines upon any piece of paper, measuring the coordinates with an ordinary scale ruler, and assigning any convenient length for the mile; the larger the scale the more accurate will be the determination. Or, what is even more convenient, we may employ "profile paper," whereon lines are ruled at right angles to each other and at equal distances apart, in which case no scale ruler is needed.

One caution must be observed in using this method; all longitudes employed on the paper for any purpose must be those of the scale, namely, one minute of longitude equals one minute of latitude. For instance, if the two Sumner lines be taken at

different times, in bringing the first up to the position of the second by the intermediate run, that run must be laid down to scale; that is, the easting and westing must appear as so many minutes of longitude, not so many miles. To do this enter the traverse table with course and distance run, and pick out latitude and departure; then, by means of the middle latitude, convert departure into minutes of longitude and bring the first line to the second by laying off so many minutes of latitude north or south, and so many of longitude east or west.

In the case where the Sumner is defined by one position and its line of direction, it is not correct to lay down the angle to the meridian on the hypothetical chart, for all angles are distorted thereon. The best way is to find another position on the line by assuming a second latitude ten or twenty miles removed from that of the point given; then enter the traverse table with the angle that the line makes with the meridian as a course, and abreast the latitude taking out the departure; convert departure into difference of longitude, and plot the second point by its coordinates from the first.

The figures show the Graphic methods of plotting Sumners—(1) on a Mercator chart, (2) by scale, and (3) on profile paper:



1 mile = .06 inch

A_1 { 40° 00′ N. / 63° 15′ W.

A_2 { 40° 20′ N. / 63° 7′ W.

B_1 { 40° 5′ N. / 63° 3′ W.

B_2 { 40° 15′ N. / 63° 12′ W.

Intersection: { 40° 12.8′ N. / 63° 9.9′ W.

Computation, using Bowditch's Tables.—The finding of the intersection of two Sumner lines by computation may be divided into two cases:

Case I. When one line lies in a NE.-SW. direction, and the other in a NW.-SE. direction.

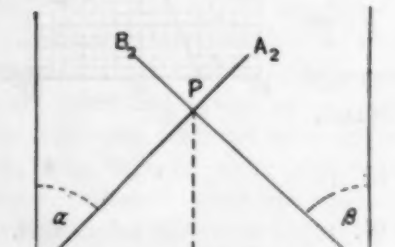
Case II. When both lie in NE.-SW., or both in a NW.-SE. direction.

Suppose that the lines are defined by the latitude and longitude of two points of each.

For the simplification of the problem it will be convenient to consider the lines projected on a plane passing through one of the meridians and making an angle with the plane of the horizon equal to the latitude, the properties of which were explained under the graphic method; this saves the necessity of converting minutes of longitude into miles of departure before the solution and converting them back again afterwards; as all points are thus projected in corresponding relative positions, the results are as exact as if the longer method had been followed.

Case I. *One line NE.-SW., and the other NW.-SE.*

Suppose the two lines, projected as described, are as shown in the figure, A_1 A_2 and B_1 B_2; for the present assume that the two points, A_1 and B_1, have a common latitude. Drop the perpendicular PO from the intersection; then the latitude of the intersection will be a distance OP above the common latitude of A_1 and B_1 and its longitude will be a distance A_1O to the right of A_1 and B_1O to the left of B_1.



Find the angles α and β from the traverse table (Table 2, Bowditch), they being taken out with the difference of latitude between the two points of the same line in the column Lat. and the difference of longitude in the column Dep. (Do not overlook the

fact that we are dealing now with the plane of projection and that α and β are not the angles made by the Sumner line with meridians on the earth's surface.)

(1) For solution by table of distance run between two bearings (Table 5 B, Bowditch); observe that the case is the same as if a ship were steaming along the line A_1 B_1 and took the first bearing of the point P when at A_1, at an angle from the course equal to $90° - \alpha$, and the second bearing when at B_1, at an angle from the course equal to $90° + \beta$, with an intervening run equal to the difference of longitude A_1 B_1; or, she may be considered as steaming from B_1 to A_1, in which case the first angle is $90° - \beta$ and the second $90° + \alpha$. Picking out of Table 5 B, corresponding to the angles given, the quantity in the *second* column, we shall have the ratio of the distance of *passing abeam*, OP, to the distance A_1 B_1; multiply the difference of longitude by the ratio, and we shall have the actual length of OP. Then entering the traverse table with this as a latitude and α as a course, we find in the departure column the distance A_1O by which the longitude of OP is defined; it is recommended also to pick out B_1O, using the angle β, which affords a proof of the correctness of all work done after the finding of α and β.

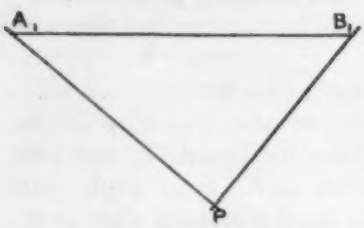
(2) For solution by traverse tables only, referring again to the figure, the method is to find by trial and error some latitude such that its departure corresponding to α, *plus* its departure corresponding to β, equals the difference of longitude A_1 B_1; then the point will be defined by the latitude and by its longitude from either A_1 or B_1.

To illustrate by example, assume the Sumner lines:

A_1	49° 40′ N. 6° 55.3′ W.	A_2	50° 00′ N. 7° 20.0′ W.	+ 20′ lat. + 24.7′ long.	Line runs, NW.-SE. $\alpha = 51°$.
B_1	49° 40′ N. 6° 32.5′ W.	B_2	50° 00′ N. 6° 11.3′ W.	+ 20′ lat. − 21.2′ long.	Line runs, NE.-SW. $\beta = 47°$.

Longitude A_1 $B_1 = 22.8'$.

First draw a rough sketch to illustrate the direction of coordinates.



Notice that A_1, is west of B_1. The line through A_1 runs NW.-SE. That through B_1, NE.-SW. The intersection is therefore south of both, east of A_1, and west of B_1.

To solve by Table 5 B: First bearing, $90° - \alpha$, $= 39°$; second bearing, $90° + \beta$, $= 137°$. Corresponding ratio, 0.43, multiplied by $22.8' = 9.8'$ lat. (The angles $90° - \beta$ and $90° + \alpha$ would have given the same ratio, 0.43.) Then (Table 2) with $\alpha = 51°$, lat. $= 9.8'$, dep. $= 12.1'$; and with $\beta = 47°$, lat. $= 9.8'$, dep. $= 10.5'$.

Hence, intersection:

9.8′ S. of lat. 49° 40′ = 40° 30.2′ N.
12.1′ E. of long. 6° 55.3′ = 6° 43.2′ W } check.
10.5′ W. of long. 6° 32.5′ = 6° 43.0′ W.

To solve by Table 2:

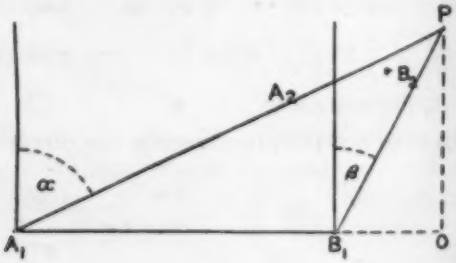
Assuming Lat.	5′	8′	10′	9.9′
Dep. for 51°.....	6.2	9.7	12.3	12.2
Dep. for 47°.....	5.3	8.5	10.7	10.6
Sum 11.5		18.2	23.0	22.8

Hence, intersection: 9.9′ S. of 40° 40′ = 49° 30.1′.
12.2′ E. of 6° 55.3′ = 6° 43.1′. } check.
10.6′ W. of 6° 32.5′ = 6° 43.1′.

The results by the two methods substantially agree.

Case II. *Both lines NE.-SW. or both NW.-SE.*

Consider the lines as drawn in the figure, and continue the assumption that A_1 and B_1 have a common latitude. The dif-



ferences from the first case by both methods simply involve a change of signs.

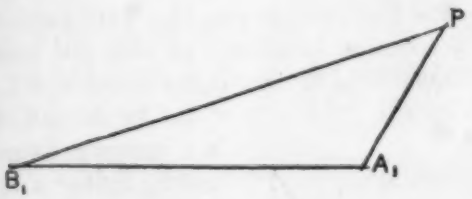
(1) By Table 5 B. If the ship is steaming from A_1 toward B_1, the first angle from the keel line is $90° - \alpha$, and the second, $90° - \beta$; if steaming from B_1 toward A_1, the first angle is $90° + \beta$, and the second $90° + \alpha$; in other words, either add both angles to 90° or substract both from 90° and enter with the smaller angle as the first bearing.

(2) By Table 2. It now appears that $OA_1 - OB_1 = A_1 B_1$; in other words, the values must be so found that the *difference* of the corresponding departures equals the difference of longitude, instead of their sums, as before.

Let us now find the intersection of the lines:

A_1	49° 30′ N. 5° 24.8′ W.	A_2	49° 50′ 5° 21.5′	+ 20′ lat. − 3.3′ long.	Line runs NE.–SW. $\alpha = 9°$.
B_1	49° 30′ N. 5° 25.8′ W.	B_2	49° 50′ 4° 52.1′	+ 20′ lat. − 33.7′ long.	Line runs NE.–SW. $\beta = 59°$.

$A_1 B_1 = 1.0'$.



In this B_1 is west of A_1, the lines both run NE.-SW. and β is the greater angle; therefore intersection lies to the N. and E. of both points.

(1) By Table 5 B. First course, $(90° + 9°) = 99°$; second course, $(90° + 59°) = 149°$; ratio, $0.67 \times 1.0' = 0.7'$; or, first course, $(90° - 59°) = 31°$; second course, $(90° - 9°) = 81°$; ratio = 0.67, as before.

$\alpha = 9°$, lat. = 0.7′, dep. = 0.1′; and $\beta = 59°$, lat. = 0.7′, dep. = 1.2′.

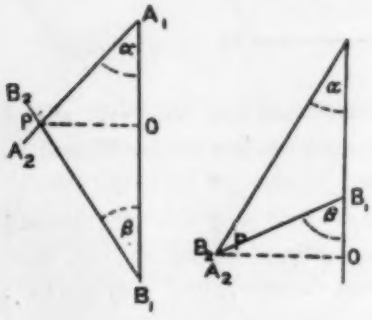
Hence, intersection: 0.7′ N. of 49° 30′ = 49° 30.7′
0.1′ E. of 5° 24.8′ = 5° 24.7′ } check.
1.2′ E. of 5° 25.8′ = 5° 24.6′ }

(2) By Table 2.

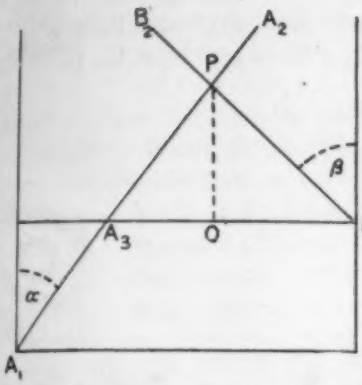
Assuming Lat.	2.0′	0.5′	0.6′
Dep. for 9°	0.3	0.1	0.1
Dep. for 59°	3.3	0.9	1.1
Difference	3.0	0.8	1.0

Hence, intersection: 0.6′ N. of 49° 30′ = 49° 30.6′
0.1′ E. of 5° 24.8′ = 5° 24.7′ } check.
1.1′ E. of 5° 25.8′ = 5° 24.7′ }

In discussing these cases, we have assumed that there was one point on each line which had a common latitude; this would be the case in the two Sumner lines worked from time sights taken at the same time. It may occur, however, (a) that they have not a common latitude, but do have a common longitude, as in the case of two lines worked from φ' φ'' (latitude) sights taken at the same time; or, (b) that they have neither a common latitude nor a common longitude, as with one time sight and one latitude sight, or with two sights taken at different times.



(a) In the case where there is a common longitude, which will be rather a rare one, the problem is worked with OP as a *longitude* coordinate; the modification of the other method will suggest itself, the principal change rendered necessary being due to the fact that the angles from the course in Table 5 B will be complementary to what they were before, as we are now dealing with angles to the meridian instead of angles to the parallel.



(b) When there is no common coordinate of either latitude or longitude, the simplest way of solving is first to find some point on one line which corresponds in latitude with one of the points on the other line, then solve as before.

Thus, in the figure, given A_1 A_2 and B_1 B_2, find α and β, then find the longitude of a point A_3 corresponding to the difference of latitude between A_1 and B_1, on the course α; after which the intersection of A_3 A_2 and B_1 B_2 is found in the usual way.

Thus, suppose we have given:

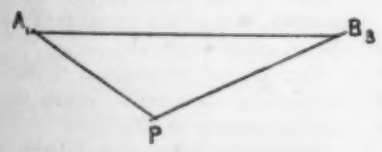
A_1	25° 30′ S. 115° 22′ E.	A_2	25° 50′ S. 115° 40′ E.	+ 20′ lat. + 18′ long.	Line runs SE.-NW. $\alpha = 42°$.
B_1	25° 15′ S. 115° 37′ E.	B_2	25° 35′ S. 115° 30′ E.	+ 20′ lat. − 7′ long.	Line runs NE.-SW. $\beta = 19°$.

Let us first find where B_1 B_2 crosses parallel 25° 30′ S.

$\beta = 19°$; lat. = + 15′; dep. = − 5.1′. Hence, the line B_3 B_2 becomes:

B_3	25° 30′ S. 115° 31.9′ E.	A_1 $B_3 = 9.9'$	Line runs NE.-SW. $\beta = 19°$.

The directions of the lines require us to follow Case I.



A_1 is west of B_3. The line through A_1 runs SE.-NW., and that through B_3, SW.-NE. Therefore the intersection is south of A_1 and B_3, east of A_1, and west of B_3.

(1) By Table 5 B. $(90° - \alpha) = 48°$; $(90° + \beta) = 109°$. Ratio, $0.81 \times 9.9' = 8.0'$ lat.; $\alpha = 42°$; lat. = 8.0′; dep. = 7.2′. $\beta = 19°$; lat. = 8.0′; dep. = 2.7′.

Intersection: 8′ S. of 25° 30′ S. = 25° 38′ S.
7.2′ E. of 115° 22′ E. = 115° 29.2′ E. } check.
2.7′ W. of 115° 31.9′ E. = 115° 29.2′ E. }

(2) By traverse table.

Assuming Lat.	6′	8′
Dep. for 42°	5.5	7.2
Dep. for 19°	2.1	2.7
Sum	7.6	9.9

Intersection: 8′ S. of 25° 30′ S. = 25° 38′ S.
7.2′ E. of 115° 22′ E. = 115° 29.2′ E. } check.
2.7′ W. of 115° 31.9′ E. = 115° 29.2′ E. }

Summary of Procedure.

By Table 5 B.

1. Write down lines. If given by coordinates of two points, find α and β.

2. If there are no points which have a common latitude, reduce one point of one line to latitude of some given point of the other.

3. Write down difference of longitude.

4. Draw rough sketch to illustrate direction of point of intersection.

5. Enter Table 5 B:

Case I, angles $(90° - \alpha)$ and $(90° + \beta)$ *or* $(90° - \beta)$ and $(90° + \alpha)$.

Case II, angles $(90° + \alpha)$ and $(90° + \beta)$ *or* $(90° - \beta)$ and $(90° - \alpha)$.

Take out ratio from *second* column, and multiply by difference of longitude; this gives difference of latitude of intersection from the common latitude.

6. Find departure corresponding respectively to α and β with latitude; this gives differences of longitude to the point of intersection from the points of each line.

By Table 2.

1. Write down lines. If given by coordinates of two points, find α and β.

2. If there are no points which have a common latitude, reduce one point of one line to latitude of some given point of the other.

3. Write down difference of longitude.

4. Draw rough sketch to illustrate direction of point of intersection.

5. Enter Table 2, at pages α and β; find by trial some latitude at which—

Case I, the sum of the corresponding departures equals the total difference of longitude.

Case II, the difference of the corresponding departures equals the total difference of longitude.

These give differences of latitude and longitude to the point of intersection from the points of each line.

If the lines, instead of each being defined by coordinates of two points, are defined by coordinates of one point with the direction of the Sumner line as deduced from the azimuth of the body, it will be better not to consider the projection on the fictitious plane through the meridian, as there will then be no advantage in so doing. In this case, consider the angles of the lines with the meridian, as given, α and β; reduce the difference of longitude A_1 B_1 to departure, and use this in miles instead of the A_1 B_1 in minutes; and when A_1O and B_1O are found, being in miles of departure, they must be reduced to minutes of longitude before being applied to the longitude of A_1 and B_1. The "Summary of Procedure" must be modified accordingly.

NOTE.—It is evident that an application of the trial and error method of the traverse table will furnish a solution for finding the distance of an object by two bearings.

DISCUSSION.

"The Defense of Our New Naval Stations." See No. 102.

Lieut.-Commander W. F. Fullam, U. S. Navy.—There can be no question that in the defense of fortified points against attack there must be united action and undivided responsibility on the part of the defenders. It is pretty generally recognized the world over that the defense of naval bases, and indeed many fortified seaports, should be left to the navy rather than to the army.

Whatever may be the policy of the United States as regards *home* ports, it is most important that the navy shall be relied upon, and shall *control* in the defense of foreign and colonial naval bases and coaling stations. There must be a complete recognition of this principle.

In no way can this desirable principle be carried out so well as by the employment of the marine corps, in the manner suggested by Captain Williams, as an expeditionary and colonial force, a permanent military organization *associated closely with the navy and working directly with the navy* in seizing important strategic points, naval bases, and coaling stations and in garrisoning and holding them against possible attack. The marine corps, as an adjunct of the navy, would thus have a distinct and important field peculiarly its own—to look out for the shore-end of the situation in all naval offensive and defensive operations abroad and in our colonial possessions, leaving the army and the navy free to perform their strictly legitimate work on land and sea. In other words, the marine corps should be the connecting link along the coast between the land and sea forces proper, working in harmony with both as circumstances demand. This is not far different from the past practice, but it should be emphasized, *and the duties and necessities of the marine corps should be more clearly defined and recognized in order to secure its complete and perfect organization and to ensure its prompt and vigorous co-operation with the navy in any emergency.*

Granting that this idea of using the marine corps as an expeditionary, colonial, and military force in close connection with the navy is sound, it remains to consider how to organize and station it to the best advantage.

Captain Williams has proposed a distribution of about 12,000 marines at navy yards at home and at several stations in our foreign possessions, which may be accepted as a guide for the solution of this particular part of the problem. This can be done in some such manner and at the same time keep the corps organized into permanent battalions and regiments, each preserving its own traditions and having pride in its own organization.

But as regards that part of the corps which is to be used directly by the several squadrons for landing purposes, defending or attacking

points in co-operation with the fleet both in time of peace and war, I would propose that the 3500 marines who are put down by Captain Williams as being "at sea"—that is, presumably, distributed among the cruising ships by companies or half companies—should be placed on board seven *armed* marine or naval transports, like the Dixie and Panther, where their battalion organization could be complete and perfect at all times, three of these transports being stationed in the East, two on the Pacific, and two on the Atlantic coasts. Thus stationed and employed, the marine would get quite as much sea experience as under the present system of distribution, and his instruction at the battery and in all necessary naval subjects *could be more thorough and systematic.* The organization being permanent and at all times in a state of perfect readiness, the force could be despatched quickly to any point, and that too without disturbing or depleting the organization on board cruising ships. With such a thoroughly organized military force, *always afloat* in readiness for immediate movement, *under the direction of the Commander-in-Chief of a squadron,* the blue jackets of the navy need not be called upon to land except in rare instances, and our ships and their guns would remain fully manned ready for their legitimate duties.

In this connection, in order to make the marine transport completely effective for every emergency as an adjunct of the fleet, it would be wise to provide it *with the means of landing, transporting and mounting some or all of its guns, large and small, in case the latter are needed on shore* to defend a base or coaling station, or for other purpose. The necessary gun platforms could be carried, and thus the batteries of these ships, as well as their marine battalions, could be thrown ashore together, *a powerful and thoroughly equipped force, quite independent of the fleet as regards its material,* and prepared to co-operate with the navy most effectively. Thus, as suggested by a commander in the navy, the transport, with its crew and its guns, becomes a "*portable fort,*" manned by marines. Seven such forts would be of inestimable value to the navy.

It is humbly submitted that such a plan is far more feasible and far wiser than to attempt to land guns of cruising or battleships either for service or exercise. The guns of the latter had best be left on board at all times, and that too with all the men who are needed to man them. To cripple a battleship, even partially, by landing some of its guns and a part of its crew does not appear very sound in principle. And if it is necessary and possible to provide the battleship for this purpose, from the gun factory and navy yards, with the gun platforms and the means of transporting its guns to the shore, it would be quite as easy and far wiser *to send the guns along too from the same points.*

It will be observed that by the plan of permanent marine transports the Commanders-in-Chief of our several squadrons may have the same number of marines as at present—if need be, *many more*—to be used in connection with their operations. The marines and blue jackets of the navy will still be serving together, just as the crews of any two ships are, and there may be the same commendable rivalry in all respects, at

target practice with all arms afloat and ashore. The only difference is that both organizations will *at all times be more perfect and more complete*, in a more perfect condition of readiness, and the functions of each will be more clearly recognized.

In advocating the withdrawal of marines from ships several years ago I proposed this system of transports; but not in its present perfection as to details. These transports should be specially designed with clear, flush spar-decks so that a column of fours could march around for drill and exercise.

This proposition need not arouse suspicion or anger. Nothing has occurred in recent years to lessen the force of the arguments for the withdrawal of marines from cruising ships. On the contrary the lessons of the Spanish War, at Manila and Santiago, in China and wherever the marines have been used so effectively will, if they are carefully studied, *serve to strengthen this argument for permanently manned transports with complete battalions of marines*, leaving the cruising ships with *their* organizations equally perfect, and their discipline and training equal to all the demands of peace or war. Suppose, for instance, that Dewey at Manila and Sampson at Santiago had had at their command such permanent and complete marine battalions *all ready to be thrown ashore without in any way disturbing the organization of their ships, or taking a single man from their guns?* Is it not plain that the marines of a fleet can be used more effectively and be landed more expeditiously *if they are kept together at all times?*

It is not apparent that the marine has anything whatever to lose by the proposition to give him his sea experience on board his own ship—the armed and thoroughly equipped transport. On the contrary there is every reason to believe that his efficiency would be increased and his training improved, since the marine officers would be more independent and much freer to perfect their organization and system of instruction. Each transport should have a small force of seamen for certain duties, perhaps, and enough naval officers for the necessary navigating duties, etc. The marine officers on board such ships could qualify themselves *to any extent that may be deemed desirable for general naval or ship duties.*

By this plan it would seldom be required to land blue jackets. But should it be necessary at any time, they would be more efficient than in the past, because they would have had experience in guard and sentry duty on board ship. At present, and in the past, they have been denied this duty. This has always been a case of most astonishing and inexcusable neglect to prepare our men for possible active duty of a trying and delicate nature—neglecting to instruct them in guard duty *afloat* when they *must do it on shore*. While we are considering schemes for the benefit and proper employment of the marine corps we must not lose sight of the means to promote the welfare and efficiency of our ships and of the men who man them. This subject must be tackled in a broad-minded, practical, and logical manner.

With the proposed transport system it would be easy to provide for rotation in the assignment of complete battalions to shore stations and to duty afloat, and also *to arrange a far more systematic scheme of instruction in target practice for the marines afloat and ashore, exercises at landing, transporting guns, etc., to provide for all the emergencies likely to arise in seizing or occupying a port in time of peace or war.* In fact it would be far easier to prepare and drill marines for all emergencies than at present when they are scattered around among our ships. And the battalions at far-away or unhealthful points could be relieved in turn for short cruises to other places for liberty or recuperation.

These suggestions are made in all seriousness and with the firmest conviction that they would be of mutual benefit to the navy and marine corps, serving to perfect the organization and training of each, and providing for their growth and for their more effective and hearty co-operation afloat and ashore in all naval operations.

In this discussion I have not touched upon the manifest importance of the marine transport system in securing the more effective co-operation of the navy and marine corps with the army, providing as it does for a more rapid concentration of naval and military forces. It has frequently been necessary during the operations of the past few years to transport military forces in cruising ships.

Major C. H. LAUCHHEIMER, U. S. M. C.—I beg leave to state that I have carefully considered the article and am of the opinion that the proposed method of defense of our new naval stations is most admirable, that the arguments advanced in support of the views expressed are both sound and conclusive, and that the entire paper meets with my hearty concurrence. Agreeing fully with the views expressed in the paper under consideration, I have no criticisms to make thereon, except possibly to suggest that many of the arguments advanced by Captain Williams are susceptible of stronger presentation which would necessarily make his case the more convincing, but this fact simply affects the *strength* of the argument rather than the soundness and practicability of the views expressed.

Keeping in mind the best interests of the naval service now and in the future, I cannot see how there can be any difference of opinion on the subject so far as the officers of the navy and marine corps are concerned.

It is to be presumed, however, that antagonism to the proposed scheme of defense will be found in the army in view of the fact that it would be urged by them that the placing of the defense of our naval stations in the hands of the marine corps would appear to be an innovation, whereas, as a matter of fact, it would simply be an extension of the present system, as the marine corps has always co-operated with the navy and the army and has never, so far as I know, protected a naval site, and as the placing of the army in these defenses would cause divided authority and responsibility and result in friction and consequent detriment to the best interests of the government.

The argument which may be made that the scheme is a novel one could easily be met by the counter-argument that the situation is a novel one, and that the state of affairs existing to-day is entirely different from that which prevailed prior to 1898, although the navy was long ere that alive to the necessity of defended coaling stations, but the internal political conditions were adverse to the expansion of territory beyond the original limits of the North American Continent.

The question of coaling stations has now become of the most vital importance and inseparably connected therewith is the question of the defense of those stations when once established. It seems to me that every argument is in favor of the homogeneity which will result from these stations being in all respects under one head and under the jurisdiction of but one branch of the executive departments.

Besides the personal pride which I naturally feel in seeing the scope of duty of the marine corps extended, I am of the honest opinion that the plan suggested by Captain Williams is the one which will ensure the greatest benefit to the government.

Section 1619 of the Revised Statutes permits the President to assign the marine corps to duty in the forts and *garrisons* of the United States on the *seacoast*, and I do not doubt but that a liberal construction of said paragraph gives to the President ample authority to assign the marines to the duty of manning such defenses as may be deemed necessary properly to protect the coaling and other naval stations which are established by executive authority in our outlying possessions.

It is believed that the scheme proposed by Captain Williams is certainly worthy of a trial, and if this be made I do not doubt but that the results thereof would be sufficient to convince the country of the advantage of said scheme. It is earnestly hoped that the service will agree with Captain Williams and unite in forcing to an issue this matter which is of so much importance to its future usefulness.

Major GEORGE BARNETT, U. S. M. C.—Without entering into the old discussion as to the usefulness of marines in the navy, I feel certain that very few officers of the navy will, under the present changed conditions, argue that marines are no longer needed in the navy, therefore why not all pull together and try to accomplish what is best for the service in general. I can say positively that no marine officer ever thinks of being anything but pleased at every increase the navy receives, and I hope the time will come when all naval officers will feel the same towards the marine corps; for after all the increase of the marine corps only adds to the navy, both ashore and afloat, for the marine corps is now, more than ever, a working part of the navy.

The point made by Captain Williams of increased efficiency resulting from the Commander-in-Chief afloat having full command ashore and afloat at naval bases is *absolutely* essential if any satisfactory results are to be attained, and in my opinion cannot but meet the approval of all thinking officers of the army or navy, as well as of those making or administering the laws.

The point made as to the relative expenses of army or marine corps is no minor matter, for in transportation alone the saving would be enormous. And besides at many of the places to be guarded naval supply vessels would be necessary for supplying water and other supplies even with an army guard, for I cannot believe that it is the policy of the government to keep up an army transport service at the necessary very great expense.

The point made in reference to the exchanging, from time to time, the marines from ship to shore and vice versa is most important, and in most cases would save the expense of sending so many sick men to hospitals or home, and this exchange could be made without expense or friction.

In reference to the necessary increase in the marine corps it certainly should be made gradually and every effort should be made to get as many officers as possible from the Naval Academy. The new Naval Academy could easily accommodate many more cadets than the number now allowed by law, and I am sure that no reason can be offered for keeping up the present policy of appointing young men with no military training, when a government school like Annapolis could easily furnish all that are necessary. If, as no sensible person will question, the Naval Academy is a good school, where the best possible training is given, why should not all vacancies in the lower grades of commissioned officers of the line and marine corps be filled from there? I am very sure that better service would be secured, and better feeling prevail throughout the service. The proposed increase in the number of cadets at the academy would in time furnish enough for all branches of the service.

The necessary future instruction of both officers and men should be pushed and every facility should be offered by the navy to make a success of this most important subject, for it is not only a marine matter but a naval matter.

In order to demand the best, the pay of some of the grades in the increased marine corps would have to be materially increased, and as with the past great increases in the pay of enlisted men in the navy, the money would be well spent, for increased efficiency is always worth its extra cost.

As to the increase in the commissioned officers, I think it naturally should follow the increase of the corps, it should come without petty jealousies on the part of any one. The time has passed when the marine corps was simply considered as a police guard ashore or afloat—it must be considered a naval expeditionary force, always ready for instant duty ashore or afloat in any part of the world, and particularly wherever a Commander-in-Chief finds it necessary to land troops, or where it is necessary to guard naval bases or coaling stations. The millennium has not arrived, and as always heretofore, divided command and divided responsibility will not result in the greatest efficiency, hence the Commander-in-Chief of the naval force must also command the

troops guarding his coal depot or naval base, and this necessary command can only be attained by having the marine corps for such duty.

Lieut.-Commander W. WINDER, U. S. Navy.—If we deduct certain general propositions which I believe to be universally accepted, Captain Williams' essay on "The Defense of our New Naval Stations" resolves itself into a special plea for the use of marines instead of the army for garrisoning these places, and his argument appears to be based upon the following suggestions:

(a) The defense of coaling stations to be under the sole control of the Navy Department.

(b) Land defenses to be manned by marines.

It appears to me that Captain Williams has supported his position by excellent reasoning, and as mere abstract propositions, the above (a and b) seem to me to have been established. The following *practical* difficulties suggest themselves:

1st. Intense opposition on the part of the army; and,

2d. The improbability of appropriate legislation.

History unfortunately tends to corroborate the writer's doubts concerning complete harmony between the army and navy in combined operations. Nevertheless, when this state of affairs occurs, it is an inexcusable evil, and, as it appears to me, one rather to be faced than avoided. Behind both army and navy is the administrative power of the government. And to this power belongs the duty of seeing to it that friction is suppressed. We have a right at least to hope that hereafter this power will profit by past experience.

I regret that I am unable to agree with some of the views of Lieut.-Commander Fullam. These views are in line with the position maintained by Mr. Fullam for many years, favoring the segregation of the marine corps. In my opinion it is as true to-day as at any previous time that the *raison d'etre* of this corps consists in its duties as ship's guards, and incidentally in policing naval shore stations. I, for one, should regard the withdrawal of marines from cruising vessels as a real calamity to the service. And I have found that many commanding officers with whom I have discussed the subject take the same view. Every movement in the direction of segregation means a tendency towards estrangement between this gallant corps and the greater organization which has so long taken pride in the intimate association which has always existed, and which I hope always will exist between them. It may be, as Mr. Fullam states, that "It is not apparent that the marine has anything whatever to lose by the proposition to give him his sea experience on board his own ship, etc.," but what about the navy? Apart from its usefulness in many other ways, the marine guard lends an element of military "smartness" to the organization of the ship's company. This cannot be expected from blue jackets. Not only their training (which *might* be modified), but their uniform (which doubtless never *will* be radically changed) practically prohibits military

smartness. In more than thirty years' service I can recall no instance of what I judged a really well "set up" blue jacket who had not previously served as a soldier or marine. This does not mean that sailors do not have a smartness of their own—that is, some of them—but it is about as reasonable to look for military stiffness in a blue shirt as in a suit of overalls. Imagine a blue jacket in white glove for instance! And yet what commanding officer would willingly dispense with these exponents of military neatness in the cabin orderly? This may appear frivolous; but it is not intended to be so. The fact that appropriate dress is essential to military smartness (and all that military smartness implies) has been recognized and acted upon since armies have existed. And while recent events have shown that under the conditions of modern warfare this element has lost some of its importance, it is by no means to be despised.

Moreover, if marines were withdrawn from cruising ships and massed on board separate vessels, how long, in the natural course of events, would it be before a certain spirit of independence of naval authority would begin to exist, and the very sources of friction dreaded in the case of the army by Captain Williams arise?

I understand that it is claimed that the withdrawal of the guards from ships would tend to promote military smartness in the blue jackets. To my mind, advocating the withdrawal of an example in order to promote a given quality seems a curious contention. At any rate I, for one, prefer to leave this experiment to future generations.

I think Mr. Fullam is quite right in what he says concerning the landing of guns from the batteries of cruising vessels. But, as it appears to me, extra guns and mounts might be carried on colliers or other auxiliary vessels.

Commander J. C. WILSON, U. S. Navy.—The necessity for coaling stations is no longer a question. Not only is their necessity recognized by all governments possessing naval forces, but many have already been acquired by our own government and efforts are still making for acquiring additional ones. Having these stations, it becomes necessary to adequately defend them, otherwise, they become a source of weakness rather than of strength, and the best method of such defense—especially as regards the personnel—is a very important matter to determine. The subject for discussion is, therefore, well chosen.

I go farther than Captain Williams in his opinion concerning the "Importance that one Department of the Government should administer all the affairs of the co-ordinate branch of the navy both afloat and ashore," and believe that not only the garrisons of distant naval stations, but that the whole coast defense system should be under the Navy Department. This idea is set forth from no desire to increase the importance of the naval branch of the service, but because the coast defense is so intimately connected with the naval defense that it seems most illogical that they should not be controlled by the same

branch of the government. Everything which pertains to attack by forces on the water or by forces on the land against forces on the water should be controlled by the naval establishment. This question, though closely related to the subject under discussion, does not necessarily form a part of it, and confining myself to the subject in hand, I express the belief that no better plan can be adopted than the scheme of defending our distant naval bases by marines, as advocated by Captain Williams. He has set forth the advantages of this proposition so clearly and discussed the matter so logically that it leaves but little more to be said from my point of view.

In regard to the proposition of Lieut.-Commander Fullam, to withdraw the marines from the cruising vessels of the navy and place all the marines at sea on board armed transports, like the Dixie and Panther, his proposition is supported by many excellent reasons, and the plan seems to have so many points of merit to recommend it, that I am inclined to believe it a good one. I am one, however, that should dislike to see the marines entirely withdrawn from the cruising ships of our service. I have always found them most useful on board ship, and their peculiar training, and the fact that they are not expected or obliged to know everything, make them very efficient in their own line, viz., as sentries and a guard which can be landed when necessary as a unit without interfering with the organizations of the ship's company.

I am not impressed with the idea of making soldiers out of our sailors, and so do not advocate the entire withdrawal of marines from our cruising vessels. I am of the opinion that the association of the two branches of the service on ship board is beneficial, but I am so impressed with the excellence of the plan of having marine battalions embark intact, as proposed by Lieut.-Commander Fullam, that I heartily approve it.

The marine guards of cruising vessels, I think, could be reduced without injury to the service, so that none but flag-ships should have more than a sergeant's guard. The guard of this vessel was reduced at my request to a sergeant's guard, and I find it ample for all purposes, and I believe the organization of this ship is better with than it would be without it.

The marine battalion afloat on an armed vessel of the transport type would be a most efficient adjunct to a squadron, particularly on the North Atlantic and Asiatic Stations, and I should like to see such a vessel attached to these stations.

Lieut.-Commander Fullam has forcibly and clearly shown the advantages to be derived by a marine battalion afloat attached to a squadron, and with the exception of the entire withdrawal of the marine guards on cruising vessels, I think his suggestion an admirable one.

Lieutenant C. BAILEY, U. S. Navy.—1. Actual war if of sufficiently long duration usually serves to expose any false and inefficient conditions that may have arisen during long periods of peace and the or-

ganization of a military or naval service is gradually brought to a simpler and sounder basis. Red tape is dispensed with, useless and parasitical growths detached, time-killing rules of conduct abolished and all forces shaped to the one end for which men-of-war are built and men trained, viz., to fight.

2. Though our recent war was of short duration and did not severely tax the resources of our ships, yet it did tend to point the direction in which changes would be urged by the necessities of war service. So far as this applies to the question of marines it demonstrated, what would seem was already clear, that all men on board ship were needed for fighting the ship and that the marine had to become a man-of-warsman, performing the same duties as other members of the crew. In fact this had been largely brought about before the Spanish American war.

3. Again when it became necessary to seize a base for naval purposes the wisest and most expeditious manner of doing it forced itself to the front—a transport with a battalion of marines was provided and the crews of the men-of-war left intact.

4. It would seem then that a severe test of war would gradually bring about a unity of organization on board our ships and a marine transport service would in many operations prove a necessary adjunct to the navy. So far as may be judged then from recent experiences, Lieut.-Commander Fullam's comments on these two points are sound and the propositions embraced in them are worthy of serious consideration in any scheme for increasing the efficiency of the navy.

DISCUSSION.

"The School of the Officer." See No. 102.

Lieut.-Commander R. C. Smith, U. S. Navy.—I have read Lieut.-Commander Hood's able paper with much interest. His subject must have presented itself to the mind of every officer who thinks about the needs of the service. The navy has been without an accepted system of training since its reconstruction. It is now in a formative period, many efforts are making to bring about a system that will be productive of the best results; but the efforts are hampered in one way or another, and in none more than by the present shortage of officers and men.

There is another circumstance that seems to delay the adoption of a continuous business-like policy, and that is the disjointed action of our present administrative methods. Successive Commanders-in-Chief have different ideas, successive departmental and bureau administrations strive for different ends. There seems to be lacking a central force that will effect unity of action and bring about that continuous persistence, independent of change of administration, that seems so essential to permanent progress. A well-organized general staff supplies such a central force. We have none at present, but the germs exist and may develop.

Certainly Mr. Hood strikes the keynote of training in his remarks as to the value of the early development of responsibility and individuality. The most valuable faculty in a man of action is the ability to make up his mind, or to decide. Emergencies arise in which the correct course is obvious and in which the untrained man cannot, to save his life, decide to act. That is a defect that needs to be overcome in officers, and there is but one way to do it; give them early the experience of independent responsibility. Personally, the most beneficial experience that I can remember was finding myself under the Brooklyn Bridge in the East River with a broken steering-gear in the single-screw torpedo-boat Stiletto the third day after taking command. It was an anxious moment at the time, but was more valuable in experience than a cruise of watch-standing in a steamer.

Athletics are very much akin to the kind of training necessary to develop decision. A man on a bicycle, or in an automobile, has frequently to act with as much quick decision as the captain of a battleship. Not that the consequences are of equal importance, but the same ready action is as necessary in the one case as the other. In fact, often the quicker decision is required in the less important case. Thus, an officer trained in a single-screw torpedo-boat to manœuvre at high speed in a crowded harbor, or at night under the search-light, will find the twin-screw boat an easy undertaking in comparison, and the battle-

ship positively simple. The reason in the last case is that owing to the slower speed there is more time to think, and that owing to conditions of power and displacement the effects of wind and current are less in comparison and can be more readily overcome. Of course the question of the consequence of an error is not here considered. It may be insignificant in one case and vital in the other, and human nature is not so constituted as not to take note of this difference; but a most valuable object of training is to inculcate a habit of composure of action notwithstanding the stake at issue. Torpedo-boats and despatch vessels are worth developing for themselves; as a school of training for young officers nothing else is better.

I quite agree with the writer that to take risks is often commendable in a naval officer. In the merchant ship, no risks should be taken that can be avoided. In the warship, if risks are not sometimes taken in peace, they will often be shunned in war. They are necessary for the training of officers to be skillful, and what is of more importance, to have confidence. It may not be out of place to draw attention to the mathematical proposition that in a conflict between two seemingly equal fleets, the chance of success on each side is one-half, and the risk of defeat one-half. Might it not be proper then to assume a risk of about one-tenth in time of peace in order to prepare one's mind to assume one-half, or more, in time of war?

An opportunity by which valuable results may accompany these small risks, thus affording a justification, were any needed, offers itself in the work of investigating all possible channels and harbors in the neighborhood of the cruising ground that might prove of use in time of war. This does not mean taking heavy ships into uncharted waters, but is rather to familiarize officers with all possible channels and teach them to handle their ships. A rather pretty piece of work last winter in the West Indies was the taking of the squadron through the Boca de Navios into the Gulf of Paria against a two- or three-knot current. If the main channels only are used on all occasions much valuable experience is lost. The criticism that if you do so and so without orders and come to grief no court will acquit you, is as Mr. Hood would apparently agree, a poor rule of action for the court.

I doubt if I quite understand, or am quite in accord, as to the rotation advocated in the duty of junior officers. Battleships must have officers to do midshipman's duties. Now if the cadets go first to the smaller vessels, as watch officers I take it to be meant, they must go later to the battleships as midshipmen. The duties of midshipmen are best learned in the battleship squadron, where there is more going on, and more boat work, an always valuable means of inculcating responsibility. I am inclined to the belief that they should do these duties first for a year or so, and then go to the smaller vessels as watch officers. If the two years' cruise and final examination are abolished, there will be no difficulty whatever in carrying out such an arrangement; but the graduating classes must be something like 200 annually, instead of about 60 as at present.

Everyone must concede the necessity of keeping officers and men together in a ship for a cruise. This is certainly recognized in Washington, and it will be carried out as nearly as possible in the future; but a first requisite is a suitable number of officers and men. The people at large do not know how short we are in personnel. They know we have the ships, and they think that is the navy. We cannot make a mistake, when the opportunity seems favorable, in setting right such reputable citizens as we find are interested in the navy, and that means nearly all of them.

The idea of massing the battleships is most opportune. Fleet tactics have been little developed, and this would afford the opportunity of perfecting such manœuvres as may be found to be essential. In this connection there are some considerations of great importance, as I think will be conceded by most of the officers who made the West India cruise last winter, that deserve to be mentioned. The battleships are not only the manœuvring units of the fleet, but each one of them is a huge training school for men. With all concessions made in the way of lightening watch duty, nearly the whole time of the divisional officers is required to bring the men into shape. There are many ship drills that have no reference to the presence of the ship in the squadron. Such are the gunnery drills, the preliminary training of marksmen, and target practice at the shore ranges and afloat. This work is in progress all the time. It is sometimes necessary from political and other considerations for the squadron to make long cruises and stop at many ports. This has the effect of breaking into the routine of ship's work, with disastrous results as to the training of the crew. As an offset, the watch officers gain experience in squadron sailing, and the captains and navigators in navigation and pilotage. Looked at in almost every other way, a much better result would be arrived at by limiting the cruising to a selected drill ground, establishing a drill routine, as was done last winter, and following it scrupulously, giving the individual ships ample time and wide latitude to carry out their individual ship work, and then several times a month giving a whole day to fleet tactics, suspending other drills and requiring all line officers to take the deck in rotation and when not directing the particular manœuvre to be present to observe it. I believe that this method would accomplish more in knowledge of tactics and ship-handling than the present method of executing occasional manœuvres during runs from port to port, by which only the captains and the officers of the deck for the time being get the benefit, the other officers being occupied at other work. If fleet drills are made an important exercise at which all officers are required to assist, the results must certainly be more satisfactory than if carried out casually.

Papers like the one under consideration, with the discussion they merit, must prove of undoubted value to the service.

Commander J. B. MURDOCK, U. S. Navy.—While agreeing most thoroughly with most of the views advanced by Mr. Hood, I am not quite

in accord with him as to the first cruise made after graduation from the Academy. Admirable as is the training there, the midshipman comes aboard his first ship with his knowledge in a somewhat unavailable form. He either lacks confidence, or thinks he knows it all, equally objectionable phases. While, as the writer argues, the quickest way to get him on his feet, may be to send him to a small ship and throw responsibility on him from the start, this course is objectionable from the fact that his lack of practical knowledge makes extra work for his associate officers. Some graduates may take to this duty naturally, but I think the majority will be more of a care than a help to those in authority on small vessels.

Another objection to sending the raw graduate directly to a small ship is referred to by the writer,—the lack of training there obtainable in the military side of the profession. Small ships must naturally be on detached service, and from the nature of the work they are called on to perform, cannot be maintained at as high a morale as larger vessels. The latter may not be what they should be, but taken as a whole, are generally better drilled, and under better discipline and supervision than small vessels can be. I regard the first impressions that a graduate receives of the service as most valuable in forming his professional character, and if he is first sent to a gunboat, in which the daily routine is carried on in a practical but free and easy way, he is liable to gain ideas of duty which are unmilitary and will have to be outgrown before he can become a thorough naval officer. The objection to commencing duty on a small vessel at the very beginning of his naval service is therefore twofold—the raw graduate is as a rule, not qualified to perform duty efficiently, and is liable to contract non-military ideas. If he were first sent to a large ship, and given practical insight into the workings of its complex mechanism and organization he would, I think, soon get in touch with service methods and morale, and after a year could be sent to a small vessel and given responsible duty, with an assurance that he could perform it satisfactorily. With more confidence in himself, he could better approach the important duty of commanding men, and succeed better in it from the fact that they, as well as himself, appreciate his fitness for command.

I most fully concur with the writer in the absolute necessity of service in squadron. In all our naval history, heretofore, we have been accustomed to detached duty. In war, as well as in peace, ships have generally operated singly, and every commanding officer prefers and strives to obtain "independent duty." Our wars of the future bid fair, however, to be of the type which naval powers in Europe have waged for centuries—wars of squadrons, decided not by individual battles between ships but by decisive fleet actions, and it is of the utmost importance that we should acquire the methods of handling vessels in squadron. It will be all the more difficult for us, from the fact that we inherit no habits of this kind, but on the contrary, have throughout our whole history followed single-ship methods. The battles of Lake Erie

and of Santiago are the only fleet actions we have fought with both fleets under way, while our history abounds in single-ship actions, which had but little influence on the result of the wars in which they took place.

The rôle of the cruiser is, of course, largely on detached service, and until recent years we have had only a cruiser navy. We must now look forward to fleet actions, and in these will meet and must use battleships. We should at the very outset recognize the fact that the battleship is naturally gregarious, while cruisers are perhaps unsociable. I fully agree with the contention of Mr. Hood that we should systematically keep our battleships together, and try to outgrow the idea which comes so naturally to us of scattering them over the world singly. Battleship service and squadron service should become synonymous terms, each expressing the highest phase of naval duty. A large proportion of officers in the service have never been in squadron, and have therefore no practical acquaintance with the methods which must rule in our tactics in the future. The best way to overcome this defect seems to be to keep the battleships always together, and detail cruisers and gunboats to act with them from time to time as opportunity occurs. Two battleship squadrons, one permanently in the Atlantic and the other in the Pacific, would give our navy the same professional training that Great Britain obtains from the Mediterranean and the Channel Squadrons, and fit our personnel, both officers and men for the work which may lay ahead of them in war. Scattering battleships all over the world is dissipating energy and wasting opportunity for training.

Mr. Hood's argument is based on the necessity for giving all officers military training. With this must be considered the training of junior officers in the engine room. This cannot be neglected, and although it is as impossible to make all officers expert engineers as it is to make them all good navigators, everyone must have a chance to gain practical knowledge and develop any aptitude he may have for engineering work. There is just as large a percentage of Academy graduates endowed with an aptitude for engineering work to-day, as there was in the days when engineer officers were graduated, and if this aptitude is not developed, the service is the loser. The scarcity of officers for line duties, has heretofore interfered with engine-room training, but this condition may pass away soon, and then at least one-third of the time should be passed in the engine room during an officer's first two cruises. If he develops special aptitude for the work, provide still further opportunity. This is a most important branch of work in the "School of the officer," and cannot be neglected.

Lieutenant C. M. McCormick, U. S. Navy.—The thanks of the service are due the author of the paper "The School of the Officer," and while heartily agreeing with him in his well thought out conclusions, particularly those concerning the assignment of officers, I desire to call particular attention to that part of the school which has to do with

pilot navigation and the handling of the ship, in which, above all others, efficiency can only be gained by experience.

When it is remembered that the small ship as a rule does much more cruising and coasting than the large one, and while doing so is subjected to much severer relative conditions, for what is a storm to a gunboat is only a gentle breeze to a battleship, it cannot be doubted that the young officer absorbs more knowledge of the very portions of his profession of which he is most in need.

It should be remembered moreover, that the valuable experience and self-reliance gained on a small ship are forced on one from the nature of the service, and are, therefore, more independent of any custom of the service or individual conception of duty in any commanding officer.

According to the present custom of the service one learns pilot navigation, and the actual handling of the ship almost entirely from observation of how they are done by others. It is true the regulations provide that ships be sent to sea singly for several days in each quarter in order to exercise officers and men in working ship, yet this cruising almost invariably consists of a run from one port to another, and the junior officer gets little more instruction than he would in crossing North River in a ferry boat, for in leaving from, and arriving in port he is standing at attention with his division, and the only time he even gets on the bridge is when the ship is well at sea.

Each ship is looked upon as a machine and the highest efficiency is considered when every unit aboard knows his duty as a component part of the machine only. Undoubtedly such a conception will result in an efficient machine so long as no wheel breaks. From the larger viewpoint of an efficient naval service, however, this conception is radically wrong; it is not sufficient to have each unit efficient solely in one particular duty, but opportunities for instruction in other and more responsible positions must be availed of. In this connection it may be stated that the frequent changes in assignment of officers has not been without its compensations.

In grateful remembrance of one commanding officer who did not follow the custom of the service, but endeavored to give the officers under his command all the instruction possible when under way, I shall describe his method.

In leaving a port he would direct a certain officer to get the ship under way and take her out, at the same time directing the executive officer and navigator not to interfere unless in case of absolute necessity.

The officer laid out all the courses, made changes as he saw fit, and after the ship was at sea any mistakes were pointed out and suggestions given concerning available ranges and the various wrinkles in pilot navigation that might have proven useful, and practical questions asked, such as: why other ships leaving the harbor had not traveled over the same track; what would have been his action if at a certain point fog had shut down, or other vessels entering or leaving the harbor had endangered collision?

While coasting too, the officer of the deck was required to keep track of the navigation with the same care as did the navigator, and to this end had to keep a record book in which was entered the times and distances when passing headlands, bearings, changes of course, etc., and this record was not an empty form. It was not wise for the officer of the deck not to know how the coast current was setting and how strong.

Of course much of this was a nuisance at times, but I have yet to see the officer who passed through the school who regretted the service so spent.

Excellent as is such a system, however, the experience to be obtained while cruising only is not sufficient, and these "several days in each quarter to be spent in exercising officers and men" should be systematically spent in instruction, and it would appear that vastly more could be learned if the officers in succession were to be given tasks of practical seamanship, such as: rounding to on a range at any angle with the course, taking the ship alongside imaginary docks marked by buoys under varying conditions of wind and tide, picking up buoys, noting turning effects of rudder and screw under varying conditions, prejudging the distance that will be covered by the aid of a number of pole buoys, noting times and distances covered in coming to a full stop under varying speeds and with varying action of screws, the use of springs, and by laying off on the chart imaginary dangers and anchorages, and the officers successively exercised in utilizing ranges, danger circles and other wrinkles in navigation, to avoid the dangers and bring the ship to the exact anchorage predetermined upon. By taking an open sheet of water such as Manila Bay, it is easy to construct on it imaginary harbors, the successful navigation of which, while being safe, would require almost all the skill and accuracy in navigation that may ever be called for in actual cruising.

To make these imaginary harbors as realistic as possible, the navigator and assistant can, by plotting the actual position of the ship every two minutes on a duplicate chart, see exactly what water the ship would actually have on the imaginary harbor chart, and tell the leadsmen what to sing out. The officer running the ship would then have the soundings to aid him, and the track as plotted on the chart by the ordinary methods of navigation would by its differences from the actual track as plotted by survey methods show the amount of error at any given location.

With the experience gained by such a method of instruction undoubtedly more intelligent interest will be taken in noting how the ship is handled by others under varying conditions, and the officers will learn from the methods of others, for the difficulties to be overcome will be then appreciated.

DISCUSSION.

"THE TRAINING SHIP." See No. 101.

Commander E. B. BARRY, U. S. Navy.—I have read Lieutenant Beach's article entitled "The Training Ship" with great interest, but it seems to me a very serious error on his part to use the word apprentice as applied to persons being trained. There is no possible connection between an apprentice and a landsman under training. The one goes through a perfected course of training that is the growth and development of years and when he leaves the apprentice training service, although still a boy, should be farther and better advanced than is the landsman after serving two years of enlistment.

We are a nation always ripe for fads. At present our naval fad is the "plough boy." Given a young man 21 years old or over, who never saw salt water, and who is a past master of the plough, you then and there have the finest sailor in the world! In fact he needs so little training that within a year after leaving the plough, it is hard indeed if he should not be a petty officer. Truly, as Lieutenant Beach says "a feeling of doubt exists in the minds of many officers as to whether the training service (he means the landsman training service) is permanent in the present form, and some believe that as it exists to-day it could be improved upon." "Upon the training of a naval apprentice the government has spent much and it should be regarded as a matter of course that he should remain in the naval service as a life vocation." This never can be made to hold good in a country like ours. The restlessness of the American character and the desire to look for something better all the time, naturally take a large number of our apprentices back into civil life where their history shows they are fairly successful.

I think our people may learn in time that we must maintain a permanent naval establishment, that it must be large and that it should be efficient. To do all this will cost money. England does not play with her navy; it is her very life. Of course I know that anything English *must be* wrong, but at the same time what is done for her navy affects national existence and seems best to the English mind. I think perhaps if we came a little nearer to her training system we would do better. For my part I am opposed to filling the navy with ploughmen. I think the apprentice service should be enlarged and that the efforts making now should be directed throughout the Union, not to getting matured plough boys, but to getting the farmer boys that are not matured.

Already there are apprentices from nearly every State in the Union and their number can be multiplied indefinitely. In five or six years we can have all the trained petty officers we want.

England's navy is maintained by her apprentice system, why should not ours be.

When we get men for the navy we want men from the seacoast. If we have to recruit men let us get water-men. I do not agree with them that say all the people from the coast are undesirable, worthless and good for nothing. Outside the big cities there is a splendid element and a large field on the seaboard yet unworked, from which Americans can be gotten that are possibly as good, barring the fact they follow the water and not the plough, as our friend the plough boy. All the sounds along Virginia and North Carolina are filled with a water population with whom the plough boy cannot be compared.

Lieutenant Beach runs up against a snag when he complains of the differences of training system. Had he separated apprentices from landsmen he would have seen that an apprentice training ship is not the same as a landsman training ship and they never can be. He cites the Annapolis, an apprentice training ship, where each officer had 19 real apprentices to instruct and the Dixie, a landsman training ship where each officer had 112 real landsmen to instruct. This is not surprising for three reasons: 1st. Apprentices receive careful instruction for six months before being allowed to go to sea, hence, being at a receptive age and hugely interested they have absorbed more in the six months than the plough boy can absorb in a year. 2dly, only the qualified boys go on the training cruises where the previous training is continued. 3dly, the landsmen come from a sort of grab bag, an omnium gatherum, and literally are "chucked" aboard one of those great merchant vessels that are able to accommodate several hundreds of them. There the principal teaching they get for a long time is to keep the ship clean and to keep themselves clean, two things that may seem easy, but are in fact most difficult to learn. By the time they learn these things the few officers aboard begin to teach them other things and then begins the rivalry for record. How many men did you rate during the past six months? asks training ship A of training ship B. Two hundred and five, answers B. Why you are not in it, says A, we rated three hundred and twenty-two. So A has the best record.

Under the "Purpose of the Training Ship" Lieutenant Beach jumbles all the good points of the apprentice training system and the poor points of the landsman training system into a confused mass. Landsmen do not go to barracks for "barrack training," if he means by that the admirable system holding good at Newport. All the routine of instruction as given by him is finished by the real apprentice before he goes to sea.

Under size of training ship every word applies to apprentices and not to landsmen.

It should be recognized that "landsmen for training" are absolutely nothing else. It is impossible to make trained petty officers and leading men out of country bumpkins in five or six months. There is much more required of a man-of-war sailor now than there was thirty years ago, yet we grind out what are called seamen and petty officers fresh from the plough by a sort of sausage-meat process while the real sailor

has no chance over the glib rote examinations of people that can tell you all about it, but can accomplish nothing. The most competent sailors can "turn to" and do things the so-called educated landsman knows all about, can describe to perfection, but cannot do; for whenever these doughty seamen get into difficulties they have to call on the old "shell back" or the despised apprentice to help them out.

It is a hopeful sign that the plough boy fad is dying out. It has run its race and we may look for a better method of recruiting seamen and petty officers.

Landsmen for the navy should be landsmen and should come into the service to take their chances with every one else. By what occult principle two plough boys are found by the recruiting officer to be so different that one is to be nothing but a plain simple landsman and the other is to be a "high-toned landsman for training," in other words, he is cut out for a petty officer before he is enlisted, passes ordinary comprehension. Yet such is the case and the "educated landsman" is usually a petty officer within one year after enlistment while an apprentice after four years of steady training may possibly attain equal rank, and the every-day landsman with great good luck may hope to be discharged as an ordinary seaman. All of which shows the superiority of the "one officer to 112 landsmen" over the "one officer to 19 apprentices." Of course there are individual exceptions to these remarks. More than one young man of ability has enlisted as a "landsman for training" and has developed into a fine sailor, but let it be distinctly understood it was due to his own individuality. It would have been the same with him in any walk of life. My remarks apply to the class. In my opinion they never will make leading men no matter what is done with them until they have gone through the time-honored process of weeding-out, which requires certainly from three to four years.

It is well known that the seafaring population of the United States is not sufficient to recruit the navy; first because it is in itself too small, since we have no deep-sea commerce properly so called, to maintain a body of seafaring men, which leaves only our fishermen, the best seafaring, seagoing, sailorized body of men in the world. But fishing is their trade and they love it; hence second, our best and only seafaring class will not come into the navy, in fact they rather despise it now that "tacks and sheets have been displaced by coal whips."

We must not forget, however, we have an immense water population and on that we can draw and I believe with success. I do not wish to be understood as referring only to the watermen of the seacoast. With all due deference to the "plough-boy-bone-and-sinew party." I have a faint suspicion, born probably from my want of experience, that for naval purposes and other nautical occupations, the waterman may be (awful thought!) more capable than the ploughman and may develop into a better sailor.

Lieutenant Smith tells us the desirable landsmen from interior parts of the country are an unfailing source of supply. I do not agree with

him. Just as soon as the ploughman finds his tour around the world in a navy "boat" and his long furlough are myths, just that soon the unfailing supply will fail. No greater shock can be put on the ploughman than sending him to sea. It is an artificial life at best and one must be caught young if you are to keep him. For this and many other reasons I am opposed to hunting for ploughmen with a band wagon and kidnapping them to "feren perts." If the interior of our vast country can furnish an unfailing supply of ploughmen that we do *not* want, why cannot the same interior of the same vast country furnish an unfailing supply of boys that we *do* want? I see no reason for beguiling a young man into the navy when we know he can never make a sailor when it is just as easy, in fact easier, to get his younger brother for an apprentice without promising him anything, and letting him judge for himself.

Let us organize our training system simply on lines of expansion. After a trial of nearly thirty years our apprentice system has been found wanting only in one particular—the large percentage that do not re-enlist. If, however, one studies the after career of these boys one finds they have obtained positions far superior to anything in the power of the navy to offer them; yet such has been the inconsistency of our people that these very positions were given ex-apprentices only because they had been apprentices.

I believe all the wants of the navy can be met by increasing the number of apprentices and by the recruiting of our *water* population. Let us stop the indiscriminate collection of the ploughman petty officer and train our landsmen so that when they know something they may hope to be rated ordinary seamen.

As in the war of the Rebellion the states persisted in organizing new regiments at every call for soldiers, thus thrusting into the veteran line bodies of raw recruits, to the destruction of the power of the veteran, so we in the navy instead of absorbing the ploughman recruit into his ship, persist in keeping him huddled together, delaying his development and his proper efficiency and then thrusting him upon the general service in large bodies, destroying the efficiency of the veteran element until a new general average has been struck.

Lieutenant WALTER S. TURPIN, U. S. Navy.—I have read with great interest Lieutenant Beach's paper on "The Training Ship." Too much cannot be said on this very interesting subject, which is, and always will be, of such prime importance to the naval service.

I agree with the author that the training should be more uniform and that it should be subject to a central control. On almost every other point, however, my views and those of the author differ widely.

Why should we have cruising training ships at all? The training is not complete when the recruit leaves the training ship, in fact it is barely begun, and has to be continued on the cruising ships, why then should the training not be taken up on board the regular cruising ships right after the preliminary course at the training station? So far as I

can see there is no good reason, especially with the landsmen and even with the apprentices, were it not for the fact that the latter are frequently too small and have to grow before they can be counted as of any value on board ship.

If, however, the training ship must remain, then there is no question in my mind that it should be as nearly like the cruising ship as it is possible to make it, having in view the fact that it should not be so large that the divisions for instruction will be too large to handle. In order to properly train recruits and get the best results, they must be made interested in what they are doing. Do they take that interest when being trained on board a sailing ship, where they are almost sure to have the idea that sail and spar drills and such things will never be of use to them when they go into general service? It has been my experience that, with very few exceptions, that necessary interest is entirely absent. On the other hand, when the training ship is about the same as the cruising ship, the recruit becomes accustomed to what he will have to do on the cruising ship, and knows that what he is learning will be useful to him throughout his naval career, and, if the recruit is to prove of any value, it will be shown at once in the training ship. My experience on the Indiana, with landsmen leads me to believe that they take much more interest in what is being taught than was the case on the Essex several years before.

The methods which give good results with landsmen need not necessarily give good results with apprentices and vice versa. The reason is not far to seek. The landsmen are for the most part men while the apprentices are all boys and the same methods cannot be applied, with success, to the training of the two classes.

Lieutenant Blue has made a most valuable suggestion for the training of recruits which is especially applicable to the training of landsmen, one in which that individual experience, so necessary to thoroughness, can be had at very little greater cost in time and at a much smaller cost in officers and men taken away from the regular cruising ships.

A recruit who has gone through the course at the training station, in conjunction with which are the small gunboats, should be much better prepared for the instruction which he will receive in general service than one who has had six months or even a year on a ship like the Dixie.

In regard to the physical development of the recruit the sailing ship is unquestionably very good and especially so for apprentices, but it is not the only thing by any manner of means, as some persons would have us believe. There are any number of exercises which are equally good.

As to the formation of character, is the handling of spars and sails, under the close supervision of experienced officers and men, who are there to prevent any accidents, and ready to give instructions in an emergency, any better than handling the boats or working anchors? I, for one, very much doubt it.

On the whole I am of the opinion that the training can be carried on equally as well, if not better, on the regular cruising ships, after a preliminary course of training at a shore station, as on ships commissioned for no other purpose than training, and the plan of making all of our ships, in a measure, training ships has the advantage of giving the navy the services of the recruits during such training, and also the services of the officers, who would otherwise be engaged in the training. When there is such a demand for both officers and men to man our ships this advantage cannot be overestimated.

The war with Spain has, to my mind, shown very conclusively that, with a nucleus of experienced hands, a green crew with little or no sea experience can be developed into a very efficient one in a very short time. Why not take a lesson therefrom and employ a method of training which we know will give good results rather than one the results of which we know to be not entirely satisfactory?

I think that there are very few officers, who have had experience with landsmen and apprentices fresh from the training ships, who will disagree with me when I say that the training ship product is not what it should be when one considers the time and labor expended in its production.

DISCUSSION.

"THE TRAINING OF LANDSMEN FOR THE NAVY." See page 475.

Lieut.-Commander A. F. FECHTELER, U. S. Navy.—I so thoroughly endorse Lieutenant-Commander Fullam's article on the "Training of Landsmen" that there is very little left to say. The beauty of his ideas is, that they can be carried out immediately with the means at hand. There is a great deal of time lost in our navy, bewailing what we haven't got. "If we had electricity here instead of steam, we could shoot properly;" "if we only had thus and so we could get along, as it is, we can't do a thing." The shortest way to efficiency is to do the very best with the material furnished and it is refreshing to read an article written in that spirit. While I believe in sailing training ships of the size advocated by Lieutenant Beach in a former article, yet there is no immediate prospect of getting them and so Mr. Fullam's plan of concentrating all the training systems on such masted ships as we have, is eminently common sense. We get the men quickly that way in the regular service and certainly I should like nothing better than to have three hundred men trained in that fashion for a newly commissioned battleship. There are some points in the article that strike me as particularly good. They are applicable to all cruising ships.

Train our petty officers so as to make them correspond in importance to non-commissioned officers of the army and marine corps. It can be done on board ship. The squad system is excellent and has now been introduced on practically all ships, but there is danger of turning the squads over to petty officers not sufficiently instructed.

Make the drills spirited and *thorough*. Do not tire the men with a monotonous routine only intended to look well on paper.

Have plenty of ship's boats running—pulling boats whenever practicable.

Give the men plenty of liberty and keep the ship from seeming a prison.

This question of the management of men is of supreme importance. We get good recruits and plenty of them, but we lose a lot simply from lack of common sense and tact in handling.

I believe we waste too much time over bright work and scrubbing and painting, especially painting. Of course a ship should be neat and clean, but at the same time a ship's company that is drilled up to top notch can not have the ship looking continually like a yacht. Our inspections are a good deal to blame. They pay more attention to the condition and appearance of our materiel than to the use made of it. Ships take their cue from this and so among the many duties of the executive, those of Chief Chambermaid have become paramount.

If the men are trained from the start to be active and smart, to be

thorough and sharp in all their drills, they will naturally get into the habit of cleaning ship in better fashion, without too much dawdling.

This gives more time for drill, recreation and liberty.

Good, thorough drills, lots of amusement on board in the way of music, minstrels, books, athletics, etc., and then plenty of liberty on shore.

In other words you want a taut ship and a happy ship to make the men contented and efficient and wed them to the service.

J. H. SYPHER, U. S. N.—The ideas expressed by Lieut.-Commander Fullam, in his article on the training of landsmen are so excellent, that any expression of opinion must be in the nature of a hearty agreement.

It is evident that the opinions of the service in general are beginning to crystallize upon certain points. These opinions are of increasing value as officers have experience with our training system, either on board training ships, or with the men who have gone out into the regular service from them.

Upon one point there seems to be pretty general agreement. This is, that a better lot of men are turned out from the old style ships, than come from the converted freighters. Our types of ships used for training are so different, and the methods vary so diversely, that it naturally follows, that the results, as shown in the drafts of trained landsmen turned out, are widely different. If ships in regular service were to send in special reports as to the qualifications of the various drafts they receive from the training ships, it would soon indicate which style of training is the best, as judged by results. And it is results, that we are after. The navy needs men and has no difficulty in enlisting any quantity of raw material.

The system that most rapidly converts this raw material into sailor men, is the one best suited for us at present.

No doubt a landsman after a year's service in a training ship is better than one after only three months, but if he can in the latter time be fitted to go into the general service and continue his training there, it would be a mistake to keep him longer in a training ship.

Men *can* be trained after one month in a receiving ship or barracks, and three months on a training ship, to be excellent landsmen, and the best of them to be ordinary seamen; all much better fitted for men-of-warsmen than the ordinary merchant sailor picked up in our seaports.

To do this it is neither necessary nor desirable that the greater part of the time should be spent at sea, in fact it can be much better done if only a small portion of it is so spent.

It requires a lifetime to acquire the so-called "sea habit." In England the enlistment is for ten years, but they do not consider a man thoroughly habituated to the sea unless he has lived on it from his boyhood. It is a waste of time then for us to take men from the interior, who have never seen salt water, and try to fit a sea habit on them in three months, or even a year.

Their first impressions of the sea are apt to be unpleasant, and if we succeed in overcoming these, and in stimulating the belief that the future holds more pleasure and profit than the past, that part of the landsman's training has been well done. These young men come into the service at an age when they feel their own importance more than they ever do before or since, and when restraint is most irksome to them. They are thus apt to look upon the necessary and desirable restraints aboard ship as unwarranted confinement. If they cruise from port to port and are not given liberty, they say they are "doing time," and desert in shoals at the earliest opportunity. The navy must offer some compensations for its manifold discomforts. If they are given liberty, and especially in foreign ports, their morals, health and purses suffer irreparable damage.

It is well known that Jack ashore is a mark for all kinds of sharpers, and when Jack in addition to being a sailor happens to be a raw country lad, he is the easiest kind of a mark. If he only acquired experience it would not matter, but the chances are greatly in favor of his acquiring diseases, which cut short his career of usefulness in the navy and which may last for life.

If kept in home ports where the attractions of shore are not too enticing, liberty may be freely offered, but after the first few days will not be taken, as the sense of imprisonment is gone, and knowing that he can go ashore the sailor loses the desire to do so.

By following the plan suggested, of having one of the small gunboats or yachts assigned as a tender, the men could be brought to a high state of efficiency in a very short time, and a cruise of one week in every month in addition to the daily cruises of the tender would be all the time it would be advisable to spend at sea.

It is necessary in this connection to make a careful distinction between drill and training.

The trained landsman may go aboard a ship and never see guns such as those at which he received his only drill. His drill may be useless to him, but his training enables him to quickly pick up the new drill of the guns at which he finds himself. The college graduate may find no use for the athletics which took up so much of his time, but colleges continue nevertheless to encourage "training" in every way. Training in the navy consists in building up the recruit physically, and in inculcating habits of cleanliness, obedience, celerity, discipline, etc. These are qualities and as Mr. Fullam says we want to start the recruit with qualities and let him acquire knowledge afterwards during the whole of his career in the service.

The method of training advocated by the essayist appears to be the one best adapted for supplying the navy with good men in the least possible time. It is not mere theory, but has in great part been practically tested on the Lancaster, where it has resulted in turning out into the service over a thousand men a year, well fitted to become seamen or even petty officers by the end of their first enlistment.

Half a dozen such ships doing similar work would, I am confident, be of incalculably greater benefit to the service than the widely diverse systems now in vogue.

Lieut. LOUIS M. NULTON, U. S. Navy.—The salient features of this paper are very properly avoidance of fatigue and a sense of imprisonment; a healthy physical development in initiation; and, the simplification of the course of instruction to those elements which cannot be best developed on board the modern ship—i. e. first lessons in seamanship.

There is nothing so absolutely discouraging to a man than to subject him at the start to a system of instruction too elaborate for his untrained mind to properly grasp, and then wear him out by trying to force him to grasp it by infinite repetition and endless nagging.

The keynote to the retention of men in the service, and it does not alone refer to enlisted men, is to make the service attractive, not by a spirit of coddling, not by a relaxation in discipline, but by the relief from a hundred and one small restrictions, which give a sense of useless imprisonment. For one thing, give a man liberty when he can be spared, and as often as he can be spared without detriment to the efficiency of the ship, and do not allow him to feel that he is kept on board simply because it is custom to do so, although he may have no duties whatever.

Liberty and discipline are somewhat antagonistic, but not necessarily so if their relations are well regulated and balance is maintained. Instant punishment of abuse of privileges is an effective governor of the situation.

The very first essential to an entirely healthy system, is fully struck in Mr. Fullam's statement, "remove all sense of imprisonment." Every one has felt this, every one knows what it is, every one knows that its experience does not indicate an intrinsic dislike for the service. It is probably brought about by the same principles which prompt some officers to stay on board ship (when they might go ashore), simply for the sake of taking unto themselves the virtues of shipkeepers.

To my mind there is an imperative demand that there should be some systematization of the training, and an "office of naval training," or its equivalent, could, if properly directed in a broad spirit, produce very beneficial results. The lack of uniformity in methods and systems throughout the service is impressive, each ship being an example of that system of which the commanding officer is an exponent. As human nature is many sided, sincerity may take diametrically opposite views, each view exacting respect, but the whole conveying demoralization to the service from the standpoint of uniformity in methods and practice, hence the necessity for a central supervision and control of principles and methods on general lines. Details must be left to the man on board ship.

I believe that barracks ashore is an efficient means for attaining the first step of breaking men into habits of obedience and cleanliness.

I agree with Mr. Fullam as to the character of the training ship as exemplified by the Lancaster. I would not have a full sailing ship course of instruction, for the excellent reasons advanced by Commander Rittenhouse, but I do feel that in no way can the same physical development be engendered with the same results as the exhilarating work aloft.

The efficiency of few ships with full complements of officers, is undoubtedly greater than many ships under officered.

"The key to prompt and proper instruction of landsmen is to be found in the petty officers." There is more than the key to the instruction of landsmen in this statement. There is the key to one of the greatest and most positive elements of efficiency of the entire naval organization.

Efforts on the part of the writer to have petty officers of his division feel that they were leaders, that they were assistants to the division officer, were in some cases gratifying, in others heart breaking, in others of neutral results.

Before the petty officer can become an efficient and positive element, he must be made to feel, and the men must be made to feel, that he is of an element on a different plan from themselves. They must respect him, and he must be made to deserve their respect and exact their obedience. By reason of pay, privileges, and qualifications he must be an example to them, as the division officer should be to the petty officer and to the division. The requirements should be uniform, and such as to demand the respect of the men for the man appointed, and should not depend upon whim or favoritism. The petty officer school should be developed aboard ship, and there should be, for each division, hand-books for various subjects, that the petty officer may at his leisure study them. These are not provided to the extent they should be. There is a bountiful interest on his part, simply waiting to be properly stimulated and supplied with the necessary food for its efficient development. As a service we are woefully deficient in means, aside from the division officer's personal knowledge, of placing information in the hands of petty officers and men.

The writer has always made it a point to make drills interesting, and has by models, cards, and literature, sometimes supplied by the ship, sometimes from other sources, always been able to hold the interest of the men, always found them eager and anxious to learn, and making constant requests for "*a book on*" this or that subject. This interest on the part of the enlisted personnel is a healthy one. It should be encouraged and greater means in the shape of hand-books on all subjects supplied to ships in large number so that "Jack" may, in his spare moments read and know for himself, and be more able the next morning to intelligently digest the instruction of the division and petty officers.

The remarks of Mr. Fullam on the petty officer are true in every respect. It is one of the burning questions of our service. Some may

object to the literature feature of the scheme. To those, I would recall the fact that the American enlisted man differs from those of other services, in the fact that he is an intelligent thinking unit, not machine made, and that by the very existence of the traits of individuality and initiative is our service, our nation, what it is to-day.

I would even have the chief petty officers saluted by the men, as is done in the German service. This may not be entirely desirable, but its military value as establishing, or aiding in the establishment of, the status of the petty officer is positive.

The utilization of converted yachts for training in steering, the use of the lead, etc., is an excellent idea, one of minimum cost and maximum results.

Captain C. M. CHESTER, U. S. Navy.—The paper of Lieut. Commander Fullam on the "Training of Landsmen for the Navy" is sound in every note. The sooner the landsman can be gotten on board a regular cruiser consistent with elementary instruction in sanitation and the fundamental principles of his work, the better it will be for the service. This elementary instruction confined to a strenuous period of three months will, I believe, answer all the requirements.

In the cruiser the same instruction as given on board the training ship can be imparted and at the same time, the precept derived by association with a large number of men who are his seniors in the service, will better equip the junior for the duties of a man-of-war than the long tiresome, monotonous cruise of the improvised battleship, such as we have to resort to.

To send seven hundred men to sea in a mastless transport with insufficient officers, and a scant number of petty officers, tends to breed bad habits which are carried into the regular cruiser to its detriment.

It is impossible in these barracks on the sea to give the men individual instruction in this the only formative period they have, with the few officers the exigencies of the service allow to these vessels, and the principal problem that will fall upon them is to find something for the men to do as an offset to idleness.

How much better then to put the recruits on board of a ship like the Lancaster with flush decks and clear daylight, where the preliminary work of making a sailor can be carried on under constant supervision of those in authority. It is a well known fact that the foreign cruises with which many men are allured into the service are regarded by them as a cheap means of seeing the world, and they return from these cruises with their object accomplished and are ready to go to their homes. This they do frequently without reference to the sacred contract entered into between them and the government. There is a marked case, I understand, where men so enticed into the service by the advertisement of the recruiting office, claimed that they had an unwritten agreement with the recruiting officer which entitled them to be returned to their homes for an extended leave after they had made the

grand tour of Europe, and that the government had no right to send them to the Philippines where their services were in great demand, until at least their verbal contract had been complied with.

It is impossible for men to gain sea habits in the short period of any single cruise and therefore a location for the training ship which will give the greatest opportunity for constant and systematic drill as set forth in Lieut.-Commander Fullam's paper will be the best for the recruits. The weeks sea service in each month give the men a taste of what the sea life is and that is all that can be hoped for in a training school. They have a foundation on which to build and the structure must depend on their cruise under actual service conditions.

The period in port gives an opportunity to develop the handling of boats by the young men entering the navy and a knowledge of this work is one of the prime requisites for our man-of-warsmen of to-day. Too much importance cannot be laid on the suggestion of Lieut.-Commander Fullam, that boats should be available for officers at any time and they be encouraged to use them on all possible occasions. Why should it be difficult for officers to get passage to or from the shore or other ships in their own boats? Let the officers feel that the boats are for their use, and encourage them to use pulling boats rather than steam launches, and you will not have neglected duties because they must catch the scheduled boat for the shore. With this authority accorded them, officers would not reply to a question "are you going ashore or not?" by a hurried scramble to the deck and boat, but they would say, "no, I must finish this work and I will take my own boat later on and meet you where you will."

I would go farther than did the lecturer when he states, "But there must not be too much concentration of authority in an office on shore." I would absolutely have no "office of naval training" on shore but place it on the ship itself. "To systematize the training service and to exercise general control and supervision over the work," I would strongly favor a Commander-in-Chief living afloat and among the men whom he controls. Preferably this should be a Flag Officer who can, if he sees that one ship is managed in better detail, start the others in emulation and assimilate the benefits among the entire squadron. Then when the embryo sailor graduates from the training ship he will be qualified to carry on the same kind of work, as his mates, which under the present system is anything but uniform. An office on shore will add to the clerical work of the different commanding officers to the detriment of the object for which he is detailed to his ship.

DISCUSSION.

"A New Type of Battleship." See No. 101.

Lieutenant M. H. Signor, U. S. Navy.—The criticisms offered seem to be very valuable, and I only regret that the question of appropriate size was not discussed. We could undoubtedly do very well on a smaller displacement.

In regard to displacement in arc due to the firing of a right or a left gun, can we not prevent that altogether?

The bow 3-inch guns could not be manned when the heavy guns were firing ahead. In case of an action where torpedo attack need not be expected, these could be stowed below in reserve. Otherwise, and particularly in thick weather, they form an important part of the armament, like a small force stationed at a critically weak point in an army's position, which usually has to remain passive during the heaviest engagements, but is nevertheless necessary.

I cannot understand why there should be any question of the increased arcs of fire—they would undoubtedly be greater than in any other type. As to the question of firing fore and aft, or at extreme angles of train, I see no reason to doubt the power of the armor deck to resist it. The Amphitrite's 10-inch guns are fired very close indeed to a comparatively light bulkhead without injury. The arcs of the 13-inch guns when level would be about eight feet above the deck; the 10-inch guns, seven feet. The deck would be of 1-inch armor over either one twenty-pound plate or two of ten pounds each. It is questionable whether there should be wood covering. In my own mind I am satisfied that the arcs of fire can be maintained as proposed, that it is not a question of injuring boats, for in war time they must be kept out of the way, but the real question is to arrange the sighting hoods so as to protect the men inside from the blast of other guns. The turrets are widely separated.

I had no idea of carrying the 18-inch barbettes down to the lower armor deck. They rest upon the main deck and have supports of the same internal diameter resting on the protective deck. Thickness of supports 3-inch to 8-inch; average 6-inch and 4¾-inch respectively.

I have a few remarks to make upon Mr. Taylor's questions concerning weight available, space, sustained engine power, and the relative value of 13-inch and 10-inch guns.

On the first, only an explanation: Not having the plans and allowances of the design recommended to the Department, the comparison cannot be more than a general approximation.

In the light condition the design recommended is heavier than that proposed by about 430 tons. The hull would necessarily be 200 tons heavier.

Assuming, then, for comparison, a vessel of the type recommended

but of the size proposed, the length would be 445 feet, the beam 77 feet, and the depth 48 feet.

Neglecting the consideration of armor on sides, decks, and battery, the difference in *type* would entail a difference in weight of hull of at least 450 tons, in favor of the shorter vessel.

Transferring from the allowance for armor decks enough to make up for the weight of the ordinary plating of the main deck, which is counted as weight of hull in the department design and as weight of armor in that proposed, we have further available, 200 tons. (In case the weight of ordinary plating on the protective deck of the department design is counted as weight of hull, there would be 250 tons more available.) For the plating and framing behind and supporting the internal armor of the department design, and for the hull work in connection therewith, I imagine that 100 tons is necessary.

To a reduction of top-hamper and a change from a policy of lavishness to one of economy of weight in ship's fittings, may be ascribed a saving of fifty tons. Thus would be explained the difference of 1000 tons of Mr. Taylor's comparison. I trust that he will find time to make some more or less definite estimate of how much must go out.

Holding to the idea of a hull covered with 6-inch armor, with 8-inch at the water line, and with the two armor decks, I would, had I been restricted to the draft, freeboard and relative length (445 feet), adopted in the design recommended, have been forced to abandon the two 10-inch gun positions with their ammunition. The loss entailed would have been about 1300 tons, of which about 850 tons would have been armor, and the additional cost of dead weight material would be about $400,000. The stability would also be impaired, unless the freeboard were reduced or the beam increased.

The hull would be more vulnerable.

The disabling of one turret would effect injury serious beyond comparison with the type proposed, yet not with that recommended.

Some will not agree that this is a fair comparison, for they regard the protection of the ends as immaterial, and the retention of numerous air ports essential. But many officers will agree that this is fair—that it is inexpedient to present a large target. The sacrifice, then, for the difference in draft, length and freeboard, amounts to six 10-inch guns behind ample protection, supplied with 600 rounds of ammunition (weight entailed, 1057 tons), besides about 240 tons for coal or machinery.

Nothing can convince me that there is any commensurate advantage gained. If the design be *large enough*, it is folly to make it larger, and I cannot sympathize with the spirit that has made the dominating characteristic of all designs since the Spanish war that of top-hamper and target. That in this we follow the lead of foreign powers is not for me sufficiently soothing.

As to space available for boilers and engines: I propose greater cubic capacity of firerooms and enginerooms than in the Virginia class, of greater designed power. There is room in her to spare, both in the

living quarters and in the machinery space. The Brooklyn, of the same length as the type proposed, five-sixths the depth below the protective deck, and four-fifths the beam, developed 18,000 H. P. Her displacement is about 9000 tons. She has more room for living quarters than they know how to use.

As to sustained engine power: Some of our ships are said to be inefficient in steaming, but the case is not so general as Mr. Taylor seems to think. In some foreign navies steaming power is jealously required. The Columbia, the Oregon, the Detroit, the Olympia, and probably many others have exceeded their contract speeds—some even their trial-trip speeds—for long distances. The officers of the Wisconsin say it is no trouble to maintain a speed of sixteen knots as long as they have coal. That some of our ships are hardly able to get out of their own way has but little to do with the design. Unless their machinery needs renewing, they could, if sent to a foreign station and efficient crews put aboard, get themselves in satisfactory condition. The ability to maintain 60 per cent full power indefinitely should be demanded of every ship kept in commission and considered as available for fleet service in war. Some of our earlier types have difficulty in getting the coal to the firerooms. The regulations provide for an infinite number of steaming trials. Possibly little attention is paid to them, but there should be some record for each, and when they *can't* maintain 60 per cent full power they should be put in the harbor-defense class, repaired, or sold as obsolete.

As to the heavy gun: The 10-inch H. P. projectile, under favorable conditions, can get through most armor now mounted afloat. The 10-inch explosive shell cannot. Neither is it likely that the present 10-inch gun will be able to penetrate the armor mounted afloat ten or twenty years hence. The larger the gun, the greater the chance of making every shot count, whether A. P. or explosive, and the greater the chance of producing vital injury. The type proposed could stand 10-inch fire for a long time. It could not stand 13-inch fire with one-tenth the chance of escaping vital injury. The difference in rate of fire is slight.

The most important questions involved are: Would the turret structure, with its 14-inch plate inclined at 45°, be disabled by a single shot from any gun now mounted afloat, or by the proposed 10-inch, or by the proposed 13-inch?—or by a smaller gun. I have endeavored to outline a turret that could receive such blows, and to indicate a gun suitable for hammering a similar one. We never will know what such a turret will stand until we make it a target on the proving ground or the sea of battle. Until then we cannot definitely say what is the best type of battleship.

As to port plates in two pieces—that is intolerable, unless they meet at an angle. The single flat plate can be made if we consider it necessary.

As Mr. Taylor says, the boat question is a puzzling one, and those

who have served on battleships may be able to offer good suggestions. I will, however, venture the following: Four large boats can be carried amidships and handled with booms. In peace time a regular allowance of boats (part of them metal lifeboats) could be secured at double davits, so arranged that the *training* of the guns would not be hindered. In time of war these davit boats and all their gear would be put on shore, and six folding canvas whaleboats, of about twenty feet length, would be hung at davits at the stern, secured so as not to obstruct the fire of the guns. If time allowed, these and their davits should be sent below before action, leaving only the boats amidships. Of the large boats, two should be metal boats constructed with the following general idea: To have water-tight compartments in bow and stern available for stowing provisions; to have a low water-tight compartment amidships with a flat top, available as a fresh water tank; above this, removable thwarts for 32 men at 16 oars; this space to be suitable for countermines, heavy stores, or ashes; to have a central longitudinal, with a centerboard working through it; to have a combination force pump and windlass worked by brakes; to have a well for weighing heavy weights; to be rigged as a schooner; to be absolutely seaworthy when properly handled. The last is the most important consideration.

This paper offers a large target, if the type of ship advocated does not. Target practice is, however, important,—and targets are cheap.

I must not close without expressing my pleasure in the receipt of the criticisms offered. Except as I have here stated, and also in regard to the advisability of fixed ammunition, I am in full sympathy with the suggestions made by Mr. Taylor.

I believe that the turbine is coming fast. I shall be pleased to learn of good results from experiments with screws of adjustable pitch, for the problem seems difficult. I believe that within twenty years coal-burning ships of war will be obsolete. I believe that the bow must be suitable for strength and ready manœuvring.

Finally, I believe that high freeboard and "command," though necessary for a 23-knot liner (which may carry water ballast) and her bridge, are unsuitable for a war vessel and her battery; and when one talks of "command" I am tempted to cry "target! target! lack of stability!—TARGET!!"

DISCUSSION.

"Effect of Personnel Law of 1899 on Engineering." See No. 102.

Ensign Henry C. Dinger, U. S. N.—The article of Lieutenant Beach, on the effect of the Personnel Law of 1898 on Engineering, seems to me to strike a vital point with regard to the efficiency of U. S. naval engineering in the coming few years. It is a question that merits the honest thought of all concerned and should not be thrust aside with the optimistic idea that, somehow or other everything will come out all right anyway. This hope may of course be realized, but in so important a matter things should not be allowed to go by chance.

From observation during my experience at sea (which has extended from one year before the passage of the Personnel Law to the present time, and has been in vessels of various kinds and conditions, both as engineer and deck officer) I am led to be heartily in accord with the views expressed by Lieutenant Beach.

There can be no doubt but that the present manner of carrying out the Personnel Law is producing a situation even more unsatisfactory than as set forth by Lieutenant Beach. The article may even be considered optimistic of the conditions that will be produced if the manner of providing for engineer officers is kept going on as at present.

I also believe that this fact is widely recognized by officers of the service; but there is the dislike by all of saying that the law is not a success, and the feeling that things will adjust themselves to produce better conditions, which prevents more outspoken remarks on the inefficiency of the Personnel Law in respect to engineering.

There is no doubt but that the Personnel Law is a benefit to the service in many respects, even with regard to the amalgamation and the alternating of the duties of deck and engine room. It serves to broaden the mind of the officer in relation to the duties and work of each branch, which is valuable. It shows the mutual dependence and tends to make the officers, in charge of either branch of the duties, work together, there being the feeling that all work is for a common end and common cause. It has thus done away with a great deal of friction and working to cross purposes and tends more to homogeneity and concord than did the conditions that prevailed prior to its passage.

But the whole tendency, as Lieutenant Beach has shown, will be toward a mediocrity in engineering, and a set-back to progress. The present system produces a deck officer who knows a considerable more about engineering than formerly; which I think nearly everyone will say adds to his professional ability. But it does not produce the highly trained engineer officer who is certainly a necessity to the progress and the maintenance of naval engineering to the proper standard. We will

thus have a goodly portion of engineering knowledge widely distributed; but there will be the absence almost entirely of the expert, technical, highly trained, and experienced engineering knowledge, a certain amount of which is certainly a sine qua non of any great efficiency or progress in naval engineering.

Under the present system, or rather lack of system, the acquiring of engineering knowledge is left to chance. A midshipman after leaving the Naval Academy may or may not be sent on his first cruise to a ship where he may get a few months of engine room duty. The chances of getting engine room duty at all are, from my observation, not over 50 per cent, and as likely as not it may be the one who has no great liking or inclination for engine room duty that is ordered to it, while the one who has a leaning that way does not get it.

Supposing, however, that one with a tendency for engineering duties will get 6 or 9 months of engine room work on his two years cruise; this is a short time and he is liable at most any time to be called upon for deck duties or shifted to the deck altogether and, knowing this, he does not have all the interest and zeal to acquire knowledge of this part of the profession that he should have, and would have, if he knew that he was equipping himself with knowledge and experience that he would be certain to be called upon to apply for years and years in later life.

He knows also that almost all the subjects of his examinations for commission relate to deck duty; that his cruise report is made up almost entirely upon the captain's observation of him as a deck officer. Naturally under these conditions engineering receives but a secondary thought.

But even supposing an officer applies a large part of his time to engineering, the chances of his being ordered to engineering duty where this knowledge may be applied are entirely uncertain and indefinite. Perhaps he may never get any, and his work and study have been a loss to the service. At most, under the present system, the time engaged in engineering duties will only be a few years, not enough to gain a good amount of practical experience.

After being commissioned ensign, our young officer goes to sea. Perhaps one in four will get a few months duty in the engine room. By rule they are not to have more than a year. After this cruise there is some haphazard chance of getting the position of assistant to the chief engineer on a large ship, or in charge of the machinery of a small one. But the tenure of these positions is always uncertain.

Now, after an engineering experience such as this, which at most will not be over two or three years of engineering duty, with this in installments and years of other duty put in between, can any one expect a trained engineer capable of being put in charge of the machinery of a large vessel. Of course there will be a few isolated cases of those who have made special efforts and who have been lucky enough to have a good deal more than the average of engineering experience who may

qualify as the desired engineer. But he is the result of chance and has been developed in spite of the system and is rather an uncertain quantity to depend upon.

A great many more deck officers are required in the navy than engineers. No way of dividing the work whereby each is done alternately can be drawn up where more than three or four years can be given to engineering work. This limited experience will not produce the trained and expert engineer.

The duties of watch and division officer, navigator, and executive all lead naturally to the duties of command. Engineering duties at present lead nowhere; they should lead up to the higher positions in engineering.

Another question that may be touched upon is the question of design, building and inspection of machinery. Where is the officer, with the present training, to acquire his knowledge of the design and building of machinery? At present this is, from the nature of the case, practically left out of the course at the Naval Academy and hardly any young officers are getting a chance to acquire the practical part of this work at navy yards and engineering establishments. I expect some may think that this can be handed over to the civilian engineer, who may obtain his position more or less through political or other influence, receive more pay than the engineer officer would and, from the nature of the case would not have the practical sea going experience that is so essential for the best performance of these duties.

Will the present produced amalgamated engineer, with one and one-half or two years' experience in engineering, be capable of taking charge of engineering inspecting work and repair work at navy yards? No doubt some, after months of close study and application, will acquire enough of this knowledge to be useful, but when he has reached that stage he is very likely to be ordered away to some purely line duty and what he has learned in regard to engineering is probably never more to be called into use.

Lieutenant Beach suggests the outlines of a plan that will provide the required number of trained and experienced engineers and yet retain all the benefits that the passage of the Personnel Law brought to the service.

It is, I think, generally regarded in the navy that some change to provide for engineer officers is necessary; the making of a new engineer corps from the warrant machinists has even seriously been proposed. The plan suggested by Lieutenant Beach seems to contain the requisites and, if asked for by the unanimous voice of the navy, could no doubt be carried through when Congress takes up the revision of naval personnel, as it is expected Congress will during the next session.

The vital points of this plan, to me, appear to be:

(1) That all officers as midshipman and for a few years later be systematically trained alike in the duties of both deck and engine room.

(2) That those who discover that by natural ability and inclination

their field lies in engineering, be selected out and given a post graduate course where the higher branches of the engineering profession would be studied.

(3) That those officers who successively pass through such a course be assigned solely to engineering duty from then on.

The experience as a watch and division officer I count as beneficial to the engineer in many ways. It serves to give a better idea of how the two branches work together and gives a more varied experience in handling men under different circumstances.

The selection of officers for the post graduate course in engineering should be based on his record in engineering branches at the Academy; upon cruise reports while doing engineering duty at sea; and on an examination in engineering.

An officer having passed through such a course would then concentrate his efforts on engineering alone, knowing that he always would be engaged in engineering duties and that all his efforts to acquire this knowledge would be of some avail. He would not be detracted by thoughts of command and executive duties, but would be an engineer once and for all and could apply all his energies to that purpose. His chief aim would be along engineering lines and, unless this condition is attained, no great engineering ability will be developed.

Lieutenant Beach strikes the key note of the whole thing when he says: "The purpose of these suggested changes is to attract those officers who by experience and not by fancy alone are conscious that engineering is the proper field for their abilities; also to create conditions so that for such officers engineering ability and not efficiency in command may be the great incentive influencing them."

At present there is no special material incentive to acquire engineering ability and, under the present system, only a few years of an officer's career are to be employed in engineering duties. The prizes to be looked for by officers, such as command and flag rank and duty, are best obtained by giving to engineering but a secondary thought. In order to produce anything better than mediocrity, an incentive to acquire engineering knowledge and experience must be made and conditions must be produced where the officers that desire to equip themselves as engineers may be helped to do so, and that, if they do equip themselves, that they will be placed in the position for applying this special knowledge.

At present we still have in part a corps of engineering specialists in those officers of the old engineer corps who are restricted to engineering duties. If to those be added, in such numbers as the service requires, officers of the line below the rank of lieutenant-commander who would prefer engineering duty and who have had considerable experience in it, we would have at once a corps of engineer officers for engineering duty which could be kept filled up to the desired numbers by new officers as Lieutenant Beach suggests.

By this we lose nothing of good that we have at present and yet obtain the services of a force of trained engineers.

PROFESSIONAL NOTES.

Prepared by Lieutenant E. L. Beach, U. S. Navy.

For convenience of reference these notes are arranged as follows:

A. Notes on ships of war, budgets and personnel, the notes appearing under the head of the naval power to which they refer. Alphabetical arrangement is followed.

B. Miscellaneous notes on Armor, Ordnance, Explosives, Torpedoes, etc. The arrangement is alphabetical and the principal heads are:

1. Ammunition.
2. Anchors.
3. Armor.
4. Boats.
5. Boilers.
6. Docks.
7. Electricity.
8. Engines.
9. Guns.
10. Gunnery.
11. Liquid Fuel.
12. Submarine Boats.
13. Wireless Telegraphy.

SHIPS OF WAR, BUDGETS AND PERSONNEL.

ARGENTINE REPUBLIC.

VESSELS BUILDING.

Name.	Displacement, tons.	Remarks.
Armored Cruisers.		
General Mitre	8500	Proposed.
General Roca	8500	"

Chili and Argentina have reached an agreement which seems likely to avert the war that has hitherto appeared inevitable. Both nations are pledged to cancel all existing contracts for the construction of warships, and this agreement is to continue for five years, it being also understood that when ever either nation resolves upon awarding new contracts for naval vessels eighteen months' notice to that effect shall be given to the other party. The treaty also provides for the compulsory arbitration of disputed questions between the two powers, commits them to a joint declaration of non-intervention in the boundary controversy between Peru and Bolivia, and stipulates that neither Chili nor Argentina shall fortify the Straits of Magellan nor sell warships to a nation un-

friendly to the other. This agreement may not be wholly correct, but it will probably ameliorate the threatening conditions which have prevailed in the relations between Chili and Argentina, and if observed in good faith it will guarantee five years of peace at that point in the South-American situation where the outlook has been most disquieting.—*Army and Navy Register.*

AUSTRIA.

VESSELS BUILDING.

Name.	Displacement, tons.	Where Building.	Remarks, date of completion.
Battleships.			
A (ersatz-Loudon).....	10,600	Trieste.	Building.
B (ersatz-Drache).....	10,600	"	Ordered.
Babenberg.....	8,340	Pola.	Building; lchd. Oct., 1901.
Arpad.....	8,340	Trieste.	"
Hapsburg.....	8,340	"	"
Armored Cruiser.			
E (ersatz-Radetzky).....	7,400	Pola.	"
Protected Cruiser.			
Szigetvar.....	2,350	"	
River Monitors.			
I.....	450		
II.....	450		

The new battleships are to be fitted with Yarrow boilers.

The total estimates for 1902 are $9,474,340.

CHILI.

In the Professional Notes of No. 102 information was given of two battleships that had been ordered built by Chili in Great Britain. It is now reported that by way of cementing peace and friendship with Argentina, the latter is to take over one of these ships.

CHINA.

In June the cruiser Kai-Chih, which was built in England in 1884 and which displaced 2480 tons, exploded and sunk in a few seconds in the Yang-tse-Kiang River, killing 150 officers. The few survivors had no knowledge of the cause of the disaster.

FRANCE.

VESSELS BUILDING.

Name.	Displacement, tons.	Where Building.	Remarks; date of launch; probable date of completion.
Battleships.			
Démocratie.....	14,865	Brest.	Ordered.
République.....	14,865	"	Launched Sept. 24.
Patrie.....	14,865	La Seyne.	Ordered.
Liberté.....	14,865	St. Nazaire.	"
Justice.....	14,865	La Seyne.	"
Verité.....	14,865	Bordeaux.	"

VESSELS BUILDING.—*Continued.*

Name.	Displacement, tons.	Where Building.	Remarks, date of launch; probable date of completion.
Suffren	12,728	Brest.	Launched; nearly complete.
Jena	12,052	"	Practically completed.
Henry IV	8,948	Cherbourg.	Lchd.; practically completed.
Armored Cruisers.			
Ernest Zenan	12,550	Brest.	Ordered.
Jules Michelet	12,550	Lorient.	"
Jules Ferry	12,550	Cherbourg.	Not yet lchd.; complete 1904.
Victor Hugo	12,550	Lorient.	" " " "
Léon Gambetta	12,550	Brest.	Lchd. Oct. 26, 1901; compl. '04.
Jeanne d'Arc	11,270	Toulon.	Launched 1899.
Gloire	10,014	Lorient.	" 1900; compl. 1903.
Marseillaise	10,014	Brest.	" " " 1902.
Amiral Aube	10,014	St. Nazaire.	Lchd. May 9, 1902; compl. 1903.
Sully	10,014	La Seyne.	" June 4, '02; " "
Condé	10,014	Lorient.	" Mar. 12, '02; " "
Amiral Gueydon	9,516	"	" 1899; com. '02 under trial.
Dupetit Thouars	9,516	Toulon.	" July 5, 1901; compl. 1903.
Montcalm	9,516	La Seyne.	" Mar. 28, '00; " 1902.
Desaix	7,700	St. Nazaire.	" Mar. 21, '01; " 1903.
Dupleix	7,700	Rochefort.	" Apr. 28, '00; " "
Kléber	7,700	Bordeaux.	" Sept., '02; " "
Protected Cruisers.			
Jurien de la Graviere	5,500	Lorient.	Lchd. 1899; com. '02 under trial.
Chateaurènault	8,013	La Seyne.	Not yet accepted; machinery unsatisfactory.
Transport.			
Vaucluse	1,650	Rochefort.	Launched; complete 1902.
Torpedo Boat Destroyers.			
Pertuisane	303	Rochefort.	Lchd. Dec. 5, 1900; compl. '02.
Escopette	303	"	" " 20, " " "
Flamberge	303	"	" Oct. 26, 1901; " '03.
Baplère	303	"	" July 16, " " '02.
Barbacane	303	"	Laid down 1901.
Carabine	303	"	Launched July 21, 1902.
Francisque	303	"	Ordered.
Sabre	303	"	"
Arquebuse	303	Havre.	Complete 1903.
Arbalète	303	"	"
Mousquet	303	"	"
Sagaie	303	"	"
Epieu	303	Havre.	Complete 1903.
Harpon	303	"	"
Fronde	303	"	"
Javeline	303	"	"
Bombarde	303	"	"
Catapulte	303	"	"
Dard	303	(?) Rouen.	Ordered.
Baliste	303	(?) "	"
Mousqueton	303	Chalons.	"
Arc	303	"	"

VESSELS BUILDING.—*Continued.*

Name.	Displacement, tons.	Where Building.	Remarks; date of launch, probable date of completion.
Pistolet	303	Nantes.	"
Bélier	303	"	"
M_{25}	?	Rochefort.	"
M_{26}	?	"	"
Torpedo Boats.			
Rafale	162	Havre.	About completed.
255, 256, 257	906	"	" "
259, 260, 261	90	Bordeaux.	" "
262, 263	86 to 90	Chalons.	" "
264, 265	90	Bordeaux.	" "
266, 267, 268	87	?	Ordered.
269, 270	91	Havre.	"
272, 273	89	Chalons.	"
273, 274	91	Bordeaux.	"
275, 276	90	"	"
277	90	Saigon.	"
Libellule	40	Havre.	Building (turbine machinery).
Submarine Boats.			
Farfardet	185	Rochefort.	Launched; about completed.
Gnome	185	"	" " "
Korrigan	185	"	" " "
Lutin	185	"	" " "
Perle	70	Toulon.	Building.
Bonite	70	"	Building, ordered in 1901.
Esturgeon	70	"	" " "
Thon	70	"	" " "
Soufleur	70	"	" " "
Anguille	70	"	" " "
Alose	70	"	" " "
Dorade	70	"	" " "
Truite	70	"	" " "
Girondin	70	"	" " "
Naiade	68	Cherbourg.	" " "
Protée	68	"	" " "
Lynx	68	"	" " "
Ludion	68	"	" " "
Loutre	70	Rochefort.	" " "
Castor	70	"	" " "
Phoque	70	"	" " "
Otarie	70	"	" " "
Méduse	70	"	" " "
Oursin	70	"	" " "
Q_{32}			" " "
Q_{33}			" " "
Q_{37}			" " "
17 boats		Various places.	Building all completed by 1905.

CHATEAU RENAULT.—The trials of this cruiser gave excellent results. She is of 8300 tons displacement and was intended as a commerce destroyer. She is fitted with three screws. Her designed horsepower is 24,000. In her trials on July 31 she reached a speed of 23.88 knots against the wind and 24.19 knots with it, an average of about 24.3.

JURIEN DE LA GRAVIÈRE.—On her recent trials this cruiser made a speed of 21.5 knots. Her designed full power speed is 23 knots, but this was not attempted because of defects that developed in her central engine.

MAGELLAN.—In June the transport Magellan was commissioned as a training ship for French machinists; 100 candidates are to be admitted annually by competitive examination; the course of training is to last four years.

GOUBET: NEW TYPE OF SUBMARINE.—Particulars are to hand of the new submarine boat invented by Mr. Claude Goubet, which has just been sold to the newly-formed British Submarine Boat Company. It is said to differ very widely from the newest "Holland" type, to which the present British submarines belong. While the latter have a reserve buoyancy when submerged, and are kept under by means of horizontal rudders, the Goubet boat possesses no reserve buoyancy when beneath the water, its weight equaling its displacement. The new type, in fact, weighs nothing when submerged, and it is said that the addition of a very small weight will set it sinking. In order to keep the boat on an even keel and prevent its either rising or sinking the inventor has devised an arrangement which pumps water from a forward tank to one situated aft, and *vice versa*. The method of working is described as follows: Should the vessel incline in any direction a pendulum swings forward, and in so doing forms a connection between a motor and the batteries; the former at once commences working the rotary pump in a direction which causes the water to flow through the pipes from the lower tank to the higher, until the addition of water to the latter is sufficient to bring both the boat and tanks level again. The pendulum swinging straight then cuts off the electric current and the motor instantly stops.—*Scientific American.*

GUSTAVE ZEDE.—The submarine Gustave Zede left Toulon recently, escorted by a tug, to make an attack on certain battleships at Villefranche. Being overtaken by bad weather, however, she had to seek refuge at Salins d'Hyeres, and later, before returning, had to prolong her stay at Villefranche for twenty-four hours to rest her crew.

SILURE.—Press dispatches report that during some trials of the submarine boat Silure at Cherbourg three of the crew suffered from asphyxia, and the boat had to be raised with all speed to the surface.

GUNNERY IN THE FRENCH NAVY.—From time to time reports are received of very satisfactory, and sometimes even of extraordinary, results attained in the gunnery practice of the French Navy, as in that of some other navies also. It is everywhere recognized, notwithstanding the introduction of new arms, that the gun must still remain the chief

instrument of naval warfare, and the trials at Barrow may serve to confirm that opinion. There is no relaxation in any navy in efforts towards efficiency in gunnery, and on every hand we find increased outlay readily sanctioned for measures towards improvement in that important direction. Attention was directed in September, 1899, to what was regarded at the time as very fine target practice in the French Mediterranean Squadron at the Rocher des Mèdes. One vessel made 72 per cent of hits at a range of nearly 5000 yards, while several exceeded 50 per cent, and none failed to attain a very respectable figure. The worst practice was that of the Jemmapes (21 per cent), and the Masséna, in which accuracy appeared to have been sacrificed to rapidity. Although these results were not without parallel, they were certainly remarkable, and it was regretted, as in regard to some later practice, that particulars were wanting of the special conditions in which the trials were carried out and the exact dimensions of the target.

Quite recently the French Northern Squadron has been engaged in target practice of a specially interesting character, though with results which would appear to us to have been much less satisfactory. After the departure of the President to St. Petersburg, the squadron left Brest for Cherbourg, and in the Iroise, outside the Goulet of Brest, the practice took place. The old wooden ex-Surcouf, which has been used as a coal hulk, was towed out by the Infatigable, and left as a target for the squadron. The appearance of a modern vessel had been given to her by building a superstructure, funnel, and mast of light wood and canvas. The *Moniteur de la Flotte* and the *Yacht* agree that the weather was bad. Rain was falling, and there was a light haze, which partly shrouded the abandoned vessel from view, while a rather heavy swell was upon the water. The mean number of hits was estimated to be 12 per cent, in relation to which the *Yacht* recalls the fact that the American average at Santiago was less than 3 per cent. The hulk was 164 feet long, with a beam of a little more than 26 feet, and the range varied between 2000 mètres (2187 yards) and 4000 mètres (4375 yards). The exercise lasted about a quarter of an hour, the guns employed being the main and secondary armament, and at conclusion of that period of time the old hulk went to the bottom.

An examination of the report shows that in 340 rounds, forty-one hits were recorded. The Formidable fired seventy-four rounds with twelve hits, at ranges between 2200 mètres (2405 yards) and 3900 mètres (4266 yards), while, at the same ranges, the Courbet, in fifty-seven rounds, made only three hits, and the Amiral Tréhouart nine hits out of sixty-three rounds. The estimated range for the Bouvines and Valmy was from 3000 to 4000 mètres (3280 to 4375 yards), and the former, in forty-eight rounds, made only five hits, while the Valmy scored two out of eighteen. Another coast defence armor-clad, the Jemmapes, fired fifteen rounds with five hits, and the Dupuy de Lôme made the same score with sixty-five rounds, the range in the case of the latter being 4000 mètres. Making full allowance for the unfavorable conditions of sea and light, our contemporaries are inclined to regard these results as satisfactory, but, in view of the fact that the target was large, we cannot altogether agree with them. At any rate this record may suggest some doubt as to the actual efficiency of gunnery in the French Navy, concerning which so much has been heard. It is, perhaps, not much to the point to cite the American results at Santiago, for few

can doubt that gun fire in war is not likely to be so well directed as in the exercises of peace, and it is beyond question that the United States Navy makes much better practice now than at any time in the course of the war with Spain.—*Army and Navy Gazette.*

GERMANY.

VESSELS BUILDING.

Name.	Displacement, tons.	Where Building.	Remarks.
Battleships.			
Wittelsbach	11,900	Wilhelmshavn.	Completed. To be tried in October, 1902.
Wettin	11,900	Dantzic.	
Zähringen	11,900	Kiel.	Lchd. June 12, '01; compl. '03.
Mecklenburg	11,900	Stettin.	" Nov. 9, '01; compl. '03.
Schwaben	11,900	Wilhelmshavn.	" Aug. 19, '01; compl. '03.
H	13,000	Kiel.	Laid down 1901.
I	13,000	Dantzic.	" " "
K	13,000	Stettin.	Ordered to be compl. by 1906.
L	13,000	Kiel.	" " " "
Kaiser Karl der Grosse	11,130	Hamburg.	Lchd. 1899; practically compl.
Kaiser Barbarossa	11,130	Dantzic.	Nearly complete.
Armored Cruisers.			
Prinz Heinrich	8,868	Kiel.	Nearly complete; ready for trials.
Prinz Adalbert	9,000	"	Launched 1901; compl. 1903.
Ersatz König Wilhelm.	9,000	Hamburg.	" June 21, 1902.
Ersatz Kaiser	9,000	Kiel.	Building.
Protected Cruisers.			
Thetis	2,645	Dantzic.	Practically complete.
Ariadne	2,645	Bremen.	" "
Amazone	2,645	Kiel.	" "
Medusa	2,645	Bremen.	" "
G (Frauenlob)	2,645	"	Launched March 22, 1902.
H	2,715	"	" April 22, 1902.
I	2,645	"	Ordered.
K	2,715		Not yet ordered.
L	2,715		" "
Ersatz Elster	2,715		" "
Gunboats.			
Panther	890	Dantzic.	Lchd. April 1, 1901; compl. '02.
B	?		Not yet ordered.
River gunboats	170	"	Ordered.
Torpedo Boats.			
S 102 to S 107 (6 boats).		"	All launched; complete 1902.
G 108 to G 113 (6 boats).		Kiel.	Some launched; compl. 1903.
S 114 to S 119 (6 boats).	350	Dantzic.	Ordered.

Recent press reports state that the German Admiralty has ordered six torpedo-boat destroyers of 350 tons, 6000 horsepower, and of 28 knots speed.

PERSONNEL.—The annual German Navy List for 1902, which, dated May 1, has been just issued, shows the steady, if gradual, increase which is being made in the number of officers in the German fleet. On May 1 there were altogether 902 officers, whereas a year ago there were only 848, thus showing an increase during the twelve months of 54 officers. The 902 officers include four admirals, seven vice-admirals, 13 rear-admirals, 55 post captains, 23 frigate captains, 96 corvette captains, 223

lieutenant-commanders, and 351 lieutenants. The number of sub-lieutenants (Fahnriche zur See) is given as 530, instead of, as last year, 426, while the cadets number 201. The list also gives as the number of ships in the navy: 14 armored battleships, eight armored coast defence vessels, 13 armored gunboats, 11 first-class cruisers, 28 smaller cruisers, six gunboats, 15 school and training ships, eight special ships, and four for harbor service.

In 1881 the personnel of the German navy amounted to 11,352; in 1886, 14,682; 1891, 17,083; 1896, 21,835; 1901, 31,171; and when the naval programme of 1900 has been carried out the number will be 60,000. The number of executive officers has not increased in the same proportion, as in 1881 it was 458, and in 1901, 924. On the other hand, the number of engineers has increased during the same period from 35 to 159; that of the warrant officers from 284 to 1280; and that of the petty officers from 1459 to 5558.

Some particulars are published of the German naval programme, and also of the three new high-speed cruisers about to be laid down. As these resemble our Amethyst class recently ordered, the chief points in design may be first mentioned. They will be of less displacement, but slightly greater speed. The dimensions of the German boats will be 360 feet long, 40 feet 4 inches beam, and 15 feet 9 inches draft, while the displacement will be 2715 tons. Our new boats are to displace 3000 tons, and the relative speeds will be 22 knots and 21¼ knots, the German vessels having engines of 8000 indicated horsepower against 9800 indicated horsepower in the case of our vessels, which will thus have a greater margin for speed. The German cruisers will have 10 guns of 4-inch calibre and 10 1.46-inch weapons, so that in all points they will equal our vessels, if, indeed, they may not excel them. On construction only £63,000 is to be spent upon each this year. But at the same time, three new battleships of 13,000 tons are to be ordered from the Wilhelmshaven, Kiel, and Dantzig yards respectively, while six battleships are to be finished before the end of the financial year. These new battleships are estimated to cost £1,243,000, which is a very high figure, exceeding that for our new ships of 16,350 tons. Their speed is to be 19 knots, as compared with the 18½ knots of the King Edward VII class. They will have four 11-inch guns each, to fire two rounds every three minutes, 18 7.12-inch guns, 24 small pieces, and six torpedo tubes, so that, although the main guns are not quite so good as our 12-inch weapons, the auxiliary armament is superior to that of any of our ships of corresponding tonnage. Three armored cruisers of 9000 tons are to be pushed forward, and three protective-deck cruisers are also to be advanced in addition to the commencing of three new vessels. Two river gunboats are to be laid down and advanced to the extent of £20,000 each. Six torpedo-boat destroyers are to be completed, and six more of 350 tons laid down. Thus, the programme of new construction includes nine battleships, three armored cruisers, six protective-deck cruisers, two gunboats, and 12 torpedo-boat destroyers; and of these there are now to be commenced three battleships, three cruisers, two gunboats, and six destroyers. The new construction vote is £5,638,428, of which £3,758,300 is for hull and engines, £1,511,800 for artillery and torpedoes, and £368,328 for miscellaneous expenses. These figures are greatly in advance of the expenditure of previous years.—*U. S. Gazette*, August 9.

THE GERMAN NAVY IN 1902.—The naval outlay for the financial year amounts to over £4,254,210, as compared with £3,910,740 in 1901. Provision is made for the laying down of the two battleships K and L, of the armored cruiser to replace the Kaiser, and of three small cruisers, a gunboat, and a torpedo-boat division. The battleships of the Brandenburg class are to be considerably improved, and a large sum is voted for the purpose. Wireless telegraphy is to be introduced extensively, and a great deal of survey and hydrographic work is to go on. The three large drydocks at Wilhelmshaven are going forward actively, and great improvements are taking place at Kiel. Additions are being made to the land establishments also, and a considerable sum is devoted to Kiao-Chow.

During the last financial year, ending on March 31, 1902, there were ready two ships of the new Kaiser class, the Friedrich III and Wilhelm II, with nine older battleships, and three others of the Kaiser class were under trial or being commissioned, while the Wittelsbach, of a later class was being completed afloat, and four sisters were upon the stocks. Two battleships of a still later class, H and J, had been laid down. The later provision is indicated above. It may be interesting to note that the Wilhelm II, from the laying of the keel to the completion of the ship, was forty-one months in hand, the Wilhelm der Grosse thirty-nine months, and the Barbarossa thirty-three months. The period occupied in completing the Karl der Grosse, which was delayed by a strike, was thirty-nine months, and it is hoped that shorter periods may yet be attained. Rapid progress is being made with the Wittelsbach, Wettin, Zähringen, Mecklenburg, and Schwaben. At the same time the coast defence ships of the Siegfried class are being lengthened and improved. The Hagen has been completed, and the Beowulf Hildebrand, and Heimdall are in hand. The new cruisers are powerful armored vessels—the Prinz Heinrich, Prince Adalbert, and the ship completing to replace the König Wilhelm. Eight smaller cruisers are completing or in hand, and several others are intended to be laid down. There has been a corresponding increase in the personnel. The executive officers increased within the year from 939 to 1015, and the cadets from 526 to 601, and there were like additions to other ranks and ratings.

The new battleships H, J, and their successors are of an interesting class, and mark a considerable advance upon their predecessors. They will have a complete belt of armor and the armored deck curved down to the lower edge for further protection. Above the side armor will be armor for the citadel, and above this again for the battery, in which will be ten 6.7-inch quickfirers, and four more of the latter are to be singly in turrets at the corners of the citadel on the upper deck. All the bases of the turrets will be well protected, and the great barbettes for the 11-inch guns will be at the end of the citadel. Thus, in protection as in armament, the new ships are a great advance upon their predecessors. They displace only 13,200 tons, and "Nauticus" questions, considering the policy of large displacements adopted by other Powers, whether it would not be desirable for Germany to follow a like plan. There are, however, as he says, difficulties, for vessels of great draft cannot at present enter all German harbors, but, when the approaches have been improved, an increase in size may become possible. This writer, however, does not seem to be a strong advocate of large dis-

placements. We have selected one of his chapters as a text for our illustration of the great advance that Germany is making. This is, indeed, generally well known but cannot be too much kept in view.—*Army and Navy Gazette*, July 26, 1902.

GERMAN FIRST-CLASS BATTLESHIP ZAEHRINGEN.—The Zaehringen is one of a group of five sister battleships generally known as the Wittelsbach class. Some time ago, when the type was in its earliest stage, we devoted an article to discussing it. Since then all the ships have been launched, and most of them are now approaching completion. As the finished article differs considerably from the original conception, we make no apology for returning to the subject now, for within its own strict limitations the Wittelsbach type may claim to be the finest battleship design yet realized. Owing to their relatively small displacement the ships have, of course, their compensating disadvantage, and this is their small coal supply. This stands at 650 tons, and though a nominal 1000 tons maximum capacity is usually assigned to them in Naval Annuals, some doubt exists as to whether they are designed to take even this moderate quantity. They are, in fine, coast defence ships "writ large," such vessels being in accord with German shipbuilding policy till very recently. This economy of coal naturally tells in favor of other qualities. In speed they are quite equal if not superior to the normal battleships, in armor protection they leave little to be desired, while in gunpowder there is no ship afloat to be compared with them, save it be the Kaiser Friedrich III class, which is gunned at the expense of armor.

The armor system of the Wittelsbach type we have already described, and it will only be necessary to go over old ground here sufficiently to refresh our reader's memories, and to bring to date older particulars.

The water-line is defended by a complete belt of a maximum thickness of 9 inches, with which is associated a deck of 3 inches in thickness and a 1¾-inch splinter deck. Along the lower deck, rising forward right up the bow, cellulose is worked. Amidships for a length of 230 feet and 7 feet high is an upper belt, terminated by bulkheads that join the barbette towers. This belt is 6 inches thick, the barbettes, which rise from the protective deck—and do not merely make a strip around the guns as at first reported—are 10 inches maximum thickness. Above the upper belt on the main deck is a battery 50 feet long by 7½ feet high, 5½ inches thick, with ¾-inch screens between the guns, and 5½-inch transverse bulkheads. Ten guns are in this battery, of which four fire right astern, and two ahead with arcs of about 135 deg. The four middle guns train through about 110 deg. Above this battery four guns are carried in 6-inch turrets. These have arcs of 150 deg. Forward, around the base of the fore turret, are four guns in 5½-inch casemates, all training from right ahead to some 45 deg. abaft the beam.

The after turret, with a 270 deg. arc of fire, is on this level. On a higher level still, is the fore turret with an arc of some 240 deg. The turrets each carry a pair of 9.4-inch guns, 40 calibres long. The eighteen battery, casemate, and small turret guns are 6-inch of 40 calibres. On the flying deck are a dozen 3.4-inch 20-pounders, of which six train right ahead, and six right astern.

Apart, then, from her heavy fire, the Zaehringen has a large advantage in the high command of many guns. How great this is we can best illustrate by a table, showing the guns carried on the broadside and

ahead on the different decks in comparison with some ships of about equal date in other navies. This command of guns is comparatively little heard about, but in these days of long range firing it is an exceedingly important point. The table is as follows:

Broadside Guns.

Name..... Nation.....	Zaehringen. German.	London. British.	Suffren. French.	Pobieda. Russian.	Maine. U. S. A.	Mikasa. Japan.
	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
Level of flying deck.....	2 9.4 6 5.4	1 3	4 12 4 4	2 10 2 3	3 3	4 3
Level of upper deck.....	2 9.4 4 6	4 12 2 6 4 3	3 6	2 10 3 6 4 3	2 12 2 6	4 12 2 6 4 3
Level of main deck.....	5 6	4 6 4 3	2 6	2 6 4 3	2 12 6 6	5 6 2 3

Right Ahead Guns.

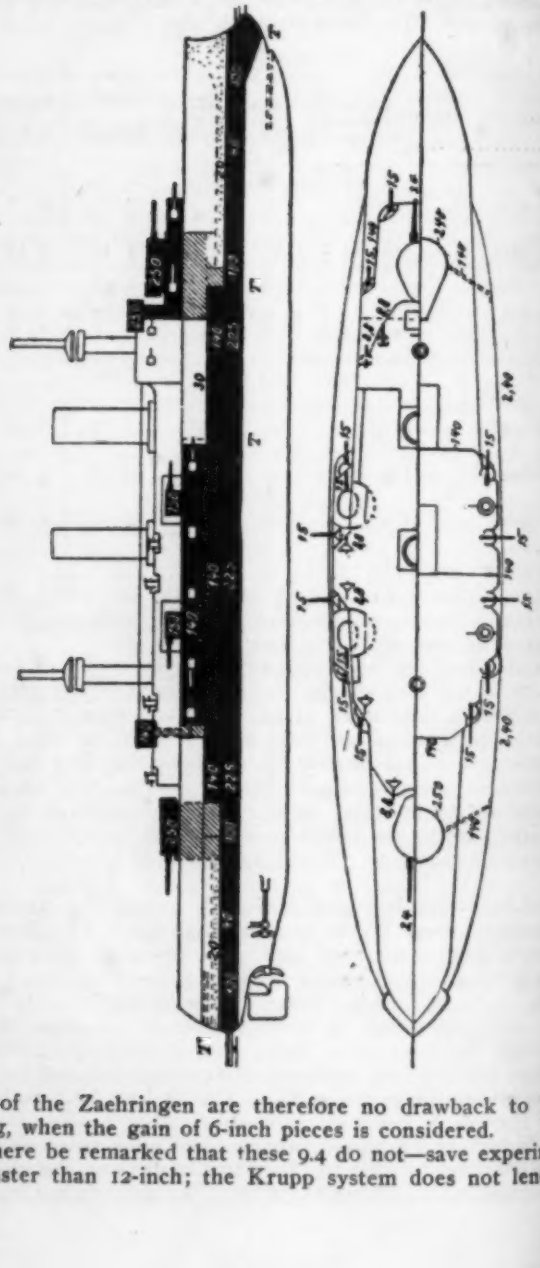
Level of flying deck.....	2 9.4 6 5.4	Nil.	2 12 4 4	2 10 2 3	2 3	4 3
Level of upper deck.....	6 6	2 12 2 6	4 6	3 6	2 12	2 12 2 6
Level of main deck.....	2 6	2 6 4 3	2 6	2 6	2 6	2 6 2 3

These figures indicate very clearly how little, relatively, British and American designs have gone beyond the low freeboard period. Big guns have gone up one deck, and that is nearly all.

The grave defect of the Wittelsbach type in the matter of interference was dealt with in our first article. It is the result of too great seeking after end-on fire—a fire more useful in theory than in practice—for since, however designed ships must ever be able to bring most fire from the broadside, it is broadside to broadside that they will generally fight. The end-on advance bow to bow is all very well on paper, but it is only one way of meeting out of many, and never, it may be said, bound to occur. Ships are infinitely more likely to converge on some common point, or nearly so. Naval warfare is not to be set out like a chessboard.

The Wittelsbach type has been criticised because she carries 9.4-inch instead of 12-inch guns. We do not incline to agree with this criticism, which is not in accord with the best naval thought. If 12-inch can be carried it is well and good, but by sacrificing these the type gains three extra 6-inch on the broadside. The 9.4's are little inferior to 12-inch in penetration, but were they so there is nothing to show that armor penetration will decide a naval fight. It will help, no doubt; but all that is written about 6-inch guns attacking casemates and big gun turrets may be written off as moonshine. On land we hear nothing about picking out the eye or heart of the hostile soldier a mile off—we deem it a stroke of luck to hit him anywhere. The same must obtain at sea, and no ship will ever be able to afford to fire guns on the off-chance of hitting some relatively infinitesimal spot. The shell with a big bursting

charge must ever be the chief projectile. The more this shell can penetrate the better, but only in so far as waste hits are thus rendered fewer.



The 9.4's of the Zaehringen are therefore no drawback to her worth mentioning, when the gain of 6-inch pieces is considered.

It may here be remarked that these 9.4 do not—save experimentally—fire any faster than 12-inch; the Krupp system does not lend itself to rapid fire.

Like the Kaiser class the Wittelsbach type is well supplied with submerged tubes. Besides the usual four there is a bow tube, which the Germans wisely adhere to. The idea that there is danger of running on to torpedoes from such tubes has never been borne out in practice. There are times when such tubes might be singularly useful. The absurdity of refusing them—as we have done—on the score of possible risk, is best evidenced by the fact that big guns if fired ahead or abaft the beam are certain to do some destruction, heavy, probably, if the operation be repeated, while rams are sure to greatly damage any ship using them. There is not a ship in the world that has trained her big bow guns as far aft as they will go, and then let both drive with full charges; nor is there a ship that would have much auxiliary battery left did she attempt it. Yet it is a far more likely accident in battle than over-running a bow torpedo.

The Zaehringen was built by Herr Krupp at his Germania Yard. She was laid down in November, 1899, and is to be ready for trials this August. The dates of laying down, builders, and completion dates of the ships of this class are as follows:

Name.	Builder.	Laid Down.	To be ready.
Zaehringen.	Krupp.	Nov., 1899.	Aug., 1902.
Wettin.	Schichau.	Oct., 1899.	Oct., 1902.
Wittelsbach.	Dockyard Wilhelmshaven.	Sept., 1899.	Nov., 1902.
Mecklenburg.	Vulkan Co.	May, 1900.	March., 1903.
Schwaben.	Dockyard Wilhelmshaven.	Nov., 1900.	Nov., 1903.

It will be noted that in Germany, as here, it takes longer to complete a ship in a dockyard than by contract. It is reported, however, that all these ships are somewhat delayed, and probably 1903 will be well advanced ere any are in commission.

All the ships of the class are fitted with six cylindrical and six Schulz-Thornycroft boilers. In H and J, now building, the proportion of water-tube boilers will be increased. The mixture is adopted chiefly to ensure that men thoroughly trained in water-tube boilers shall alone use them. It has not, we hear, been a brilliant success, owing to the difficulties bound to occur from having two distinct types of stoker. In war, when steam for full speed is, of course, an absolute necessity, this bother is likely to be felt a good deal more.—*The Engineer*, July 25, 1902.

Kaiser Karl der Grosse.—This first class battleship of 11,130 tons displacement, built at Hamburg, has recently completed her trials. On her six hours forced draft trial 13,883 I. H. P. was developed with 116 revolutions of propeller per minute, giving a speed of 18 knots.

Berlin press reports state that the projected battleships for the German navy will have the heaviest armament in the world. They will be fitted out with four 28 centimeter and fourteen 17 centimeter quick-firers, as well as thirty-two smaller guns, making a total of fifty guns. The battleships will cost 7,500,000 marks each.

In the interesting "Jahrbuch für Deutschlands Seeinteressen, 1902," which has just been published by Mittler, in Berlin, the German,

"Nauticus" has many interesting things to say and gives a table of comparative strength, which we reproduce as a matter of interest:

Country.	Battleships (launched in 1892 or later).		Large Cruisers (launched in 1897 or later).		Gross Displacement.
	Numbers.	Total Displacement.	Numbers.	Total Displacement.	
England	57 (52)	785,650	70 (29)	648,440	1,414,090
France	32 (23)	349,727	28 (23)	243,171	592,898
Russia	25 (19)	247,241	13 (5)	100,606	347,847
United States	20 (19)	248,294	16 (13)	176,155	424,449
Germany	19 (18)	212,405	11 (5)	81,780	294,185
Italy	15 (13)	189,207	6 (6)	39,813	229,020
Japan	7 (6)	93,891	6 (6)	58,776	152,667
Austria	10 (2)	75,020	3 (3)	19,040	94,060

Torpedo boat No. 42, of the German navy, was run down and sunk by a British steamer on June 24 at the mouth of the Elbe. The commander of the torpedo boat and three of her crew were missing. This boat was built by Schichau in 1889. She was 150 feet long, and displaced 153 tons. Her speed was 22 knots.

GREAT BRITAIN.

VESSELS BUILDING.

Name.	Displacement, tons.	Where Building.	Remarks, date of launch, completion, etc.
Battleships.			
Commonwealth	16,500	Jarrow.	Ordered.
Dominion	16,500	London.	"
King Edward VII	16,500	Devonport.	Begun.
Queen	15,000	"	Launched March 8, 1903.
Prince of Wales	15,000	Chatham.	Lchd. March 25; compl. '03.
Albemarle	14,000	"	" March 5, '01; " '03.
Cornwallis	14,000	Blackwall.	" July 17, '01; " '03.
Duncan	14,000	"	" Mar. 21, '01; " '03.
Exmouth	14,000	Birkenhead.	" Aug. 31, '01; " '03.
Montagu	14,000	Devonport.	" Mar. 5, '01; " '03.
Russell	14,000	Jarrow.	" Feb. 19, '01; " '03.
Bulwark	15,000	Devonport.	Launched; completed.
Venerable	15,000	Chatham.	" compl. this year.
London	15,000	Portsmouth.	" under trial, nearly completed.
Armored Cruisers.			
Drake	14,100	Pembroke.	Lchd. Mar. 5, '01; compl. '03.
King Alfred	14,100	Barrow.	" Oct. 28, '01; " '03.
Leviathan	14,100	Clydebank.	" July 23, '01; " '03.
Good Hope	14,100	Portsmouth.	" Feb. 21, '01; completed.
Hampshire	10,200	Elswick.	Ordered.
Devonshire	10,200	Chatham.	Building.
Roxburgh	10,200	Glasgow.	Ordered.
Antrim	10,200	Greenock.	"
Argyll	10,200	Clydebank.	"
Carnarvon	10,200	Glasgow.	"
Essex	9,800	Pembroke.	Lchd. Aug. 24, '01; compl. '03.
Kent	9,800	Portsmouth.	" Mar. 6, '01; " '03.
Monmouth	9,800	Glasgow.	" Nov. 13, '01; " '03.
Bedford	9,800	Govan.	" Aug. 31, '01; " '03.
Cornwall	9,800	Pembroke.	" Oct. 1902.

VESSELS BUILDING.—*Continued.*

Name.	Displacement, tons.	Where Building.	Remarks, date of launch, completion, etc.
Suffolk	9,800	Portsmouth.	Launched October, 1902.
Berwick	9,800	Glasgow.	" "
Cumberland	9,800	Glasgow.	.....
Lancaster	9,800	Elswick.	Launched Mar. 22; compl. '03
Donegal	9,800	Govan.	.....
Hogue	12,000	Barrow.	Trials finished; practically completed.
Sutlej	12,000	Chatham.	Trials finished; practically completed.
Euryalus	12,000	Barrow.	Completed in 1903.
Bacchante	12,000	Chatham.	Trials finished; practically completed.
Protected Cruisers.			
Spartiate	11,000	Portsmouth.	Completed.
Challenger	5,880	Chatham.	Launched May, 1902.
Encounter	5,880	Devonport.	" June 18, 1902.
Turquoise	3,000	Glasgow.	Ordered.
Amethyst	3,000	"	"
Gunboats.			
Odin	1,096	Sheerness.	Practically complete.
Merlin	1,096	"	" "
Espiegle	1,075	"	" "
Fantome	1,075	"	" "
Cadmus	1,096	"	Ordered.
Clio	1,096	"	"
Torpedo Boat Destroyers.			
Derwent	....	.....	.....
Eden	....	.....	.....
Erne	....	.....	.....
Exe	...	.....	.....
Ettrick	....	.....	.....
Foyle	....	.....	.....
Ichen	..	.....	.....
Ribble	....	.....	.....
Teviot	....	.....	.....
Usk	....	.....	.....
Arab	320	Clydebank.	Trials finished; complete.
Ostrich	355	Govan.	" " "
Express	430	Birkenhead.	" " "
Success	350	Sunderland.	" " "
Torpedo Boats.			
1	185	Cheswick.	Ordered.
2	185	"	"
3	185	"	"
4	185	"	"
Submarine Boats.			
1	120	Barrow.	Nearly complete.
2	120	"	" "
3	120	"	" "
4	120	"	" "
5	120	"	" "
6	?	"	Ordered.

THE EXMOUTH'S TRIAL.—The battleship Exmouth completed her 30 hours' trial at four-fifths power with the following results: speed, 18 knots; horsepower, 13,774; revolutions, 113. On the 8 hours' full-power

trial the results were: speed, 19 knots; horsepower, 18,346; revolutions, 126.6.

THE BEDFORD'S TRIAL.—H. M. S. Bedford, the first of the armored cruisers of the County class to be completed, has finished her contract trials. The mean results of the first 30 hours' coal-consumption trial, with the engines working at low power, were as follows: Steam at engines, 238 lb.; in boilers, 255 lb.; vacuum—starboard 26.8 in., port 26.3 in.; revolutions—starboard 85, port 84; indicated horsepower—starboard 2250, port 2272—total 4522; speed, 14.92 knots; coal consumption, 1.91 lb. per indicated horsepower per hour of the second trial. The mean results of the second 30 hours' trial were: Steam in boilers, 246 lb.; at engines, 222 lb.; vacuum—starboard 25.6 in., port 27.1 in.; indicated horsepower—starboard 7952, port 8053—total 10,005; air pressure, .26 of an inch; speed, 21.2 knots; coal consumption, 1.97 lb. per indicated horsepower per hour. In her eight hours' full-power trial the engines worked excellently throughout, but the estimated speed of 23 knots was not maintained, the mean being 22.7 knots. This result was the more disappointing because the engines were driven at considerably above the 22,000 indicated horsepower calculated as the maximum when they were designed. The mean results were: Steam in boilers, 285 lb.; steam at engines, 228 lb.; air pressure in stokeholds, 0.32 in.; vacuum—starboard 26 in., port 25.5 in.; revolutions—mean, 146.9; indicated horsepower—starboard 11,286, port 11,171—total 22,457; coal consumption, 2.12 lb. per indicated horsepower. The Bedford was built and engined by the Fairfield Company, Glasgow.—*Engineering*, July 4, 1902.

THE SPARTIATE'S TRIAL.—The Spartiate, cruiser, which was laid down at Pembroke more than five years ago, and was engined by Messrs. Maudslay, Sons, and Field, completed her steam trials at Portsmouth on Monday, the 14th inst. These trials have been spread over a long period, owing, first, to sand finding its way into the condensers; secondly, to the fusing of the white metal of the bearings; and, thirdly, to the extensive water leakage in the condensers, leading to the condemnation of the whole of the 12,000 condenser tubes. Several months elapsed between successive breakdowns, but at last the trials have been completely successful. When the Spartiate left Portsmouth on Friday morning, the 11th inst., she drew 24 feet 7 inches forward and 26 feet 10 inches aft; some time was spent in swinging for the adjustment of compasses, and early in the afternoon she started on her 30 hours' trial at four-fifths her power. She had 258 lb. of steam in her boilers, and the vacuum was 27.2 inches starboard, and 26.8 inches port. There was no air pressure, and with 14,000 indicated horsepower the revolutions were 111.06 starboard and 110.94 port. The speed by patent log was 19.8 knots, and the coal consumption 1.66 lb. per unit of power per hour. She anchored at Spithead at 9 o'clock on Saturday night, the 12th inst., after concluding this trial, and left again at 11 o'clock on Sunday night. She had worked up to full power two hours later, and then started on her eight hours' final trial. She then drew 24 feet 4 inches forward and 26 feet 5 inches aft, and the steam in her boilers was 260 lb., the vacuum being 26 inches. There was a mean air pressure of .17 inch, and with 18,658 indicated horsepower the revolutions were 120.5 starboard, and 119.7 port, which gave the ship a speed, as measured by

patent log, of 21 knots. The coal consumption was 1.65 lb., and the total make-up feed-water required was 25 tons. The Spartiate is the last of her class to complete her steam trials.—*Engineering*, July 25, 1902.

THE ODIN'S TRIAL.—The new war sloop Odin completed, on Monday, the 14th inst., in the North Sea, her official steam trials, which were very satisfactory. This vessel, built at Sheerness Dockyard, is of a type of which many are required to police the distant isles of the Empire. With 185 feet of length and 33 feet of beam, they displace 1070 tons at their normal draft of 11 feet 3 inches. Under ordinary circumstances their great spread of canvas enables them to sail from point to point; but when baffled by contrary breezes or calms, the vessels resort to steam. They have twin sets of triple-expansion engines, and although the total power is but 1400 indicated horsepower, there are difficulties of design, since only 160 tons are allowed for boilers and engines and all auxiliaries. The Odin's machinery has been supplied by the Wallsend Slipway and Engineering Company, and Mr. Andrew Laing, their general manager, was present at the trials. On the full-power run the steam pressure was maintained at 216 lb. in the four Babcock and Wilcox boilers, and the starboard engine, making 199 revolutions, indicated 709 horsepower, while the port set gave 711 indicated horsepower for 200 revolutions. The collective power was thus 1420 indicated horsepower. The coal consumption was 1.54 lb. per horsepower per hour, while the speed of the ship proved to be 13½ knots. On the 30 hours' trial at three-fourths power the coal consumption worked out at 1.5 lb. per horsepower per hour, while the power was 1026 indicated horsepower for 174 revolutions. The starboard engine indicated 516 horsepower and the port engine 510 horsepower. At the 30 hours' trial at one-fifth of the full power rate, at which the most of the ship's steam cruising will be done, the full consumption was 1.52 lb. per horsepower per hour, the engines running at 122 revolutions, indicating 308 horsepower. On this trial the steam pressure was 208 lb. The trials throughout proved most favorable.—*Engineering*, July 25, 1902.

THE TRIALS OF H. M. S. DRAKE, AND PROPELLER EFFICIENCY.—The new armored cruiser Drake has just completed her contract steam trials, and in reviewing the results chief interest attaches to the alterations made in connection with the propellers to determine the efficiency as compared with those on the sister ships Good Hope and Leviathan. All three ships are alike in their model; their machinery is of the same dimensions, differing only in detail. The propellers are of the same diameter—19 feet 2 inches—and the form of blades is the same; but the pitch can be varied, and the Admiralty decided to try successive ships with the screw blades set at a different pitch in each vessel. Thus there is being obtained a series of results with full-size vessels on a problem in propulsion about which relatively little is known, although it is of first-class importance. The Good Hope went through her trials with her propellers set at a mean pitch of 22 feet 9½ inches. The Leviathan was tried with her screws at 23 feet 9½ inches, and the Drake had them altered to a maximum possible, with the dimensions adopted, to 24 feet 6 inches. The King Alfred, which belongs to the same class, will shortly go upon her trials, and it is probable that she will have new propellers made so as still further to increase the pitch. The results obtained are

of great importance. The increased pitch, it is considered, improved the speed, for at full power the Good Hope steamed 23.05 knots, the Leviathan 23.25 knots, and although the Drake only made 23.05 knots, the steering was not quite satisfactory, the ship yawing badly. The loss in slip at full speed was less, being for the Good Hope 18.5, for the Leviathan 18.5, and for the Drake 18 per cent. A further advantage is in the reduction of revolutions for a given speed of ship. Thus the Good Hope's engines had to run 126.2 revolutions, the Leviathan 122.1, and the Drake only 116 revolutions. A reduction of 80 feet per minute in the piston speed of such high-power engines is a great relief to bearing surfaces; and, other things being equal, there is here a justification for increasing the pitch. The same point applies to the results at three-fourths power; but here the slip has increased with the increase of the pitch. The Good Hope had only 9.6 per cent slip, the Leviathan

Mean Results of Speed Trials of H.M.SS. Drake, Leviathan, and Good Hope.

Revolutions.	Indicated Horse Power.	Speed in Knots.	Percentage of Slip.	Coal Consumption.
		H.M.S. Drake.		lb. per I.H.P.
72.3	6,937	15.43	11.8	1.73
105.9	23,103	22.08	13.9	1.78
116	30,587	23.05	18	1.88
		H.M.S. Leviathan.		
71.2	6,481	15.238	8.5	1.73
107.6	22,900	21.96	12.8	1.71
122.1	31,592	23.25	18.7	1.84
		H.M.S. Good Hope.		
77.5	7,953	15.91	8.4	1.87
109.1	23,467	22.10	9.6	1.88
126.2	31,088	23.05	18.5	1.91

12.8 per cent, and now the Drake's slip increases to 13.9 per cent; but engineers do not require to be reminded that such an advance in slip does not necessarily mean less efficiency, as the question of frictional loss is a factor of importance. This increase in slip applies also to the low-power trials. The results are given in tabular form for all three ships in the Table in the preceding column. In each case the four low-power speed runs were made over the measured mile at Stokes Bay at the top of the tide; and the higher speed trials over the long deep-sea course between Rame Head and Dodman Point. The coal-consumption results were obtained on the extended trial, which was of 30 hours' duration at one-fifth and three-fourths of the power, and of 8 hours' length at full power. The Drake, which is 14,100 tons disulacement, was built at Pembroke Dockyard, and engined by Messrs. Humphrys, Tennant and Co., London.—*Engineering*, June 27, 1902.

THE SPEED TRIALS OF THE DRAKE AND PROPELLER EFFICIENCY.—Dr. Froude, when he developed the system of testing the resistance of ships by model experiments, pointed the way to a great improvement in naval architecture, and enabled the designer to lay down the lines of his ship so as to develop a form which would give a most economical speed result from a predetermined horsepower with almost a certainty of attaining the result desired. But there still remained the one disturbing element of the form of propeller. Means have been devised of carrying out experimental trials with models of propellers in a manner analogous to that for ship hulls. Yet the results, while interesting, have

proved approximate rather than precise. This is the more to be regretted as the propeller is the unit in the mechanism for the propulsion of ships, regarding which there is least scientific surety. The Admiralty, therefore, have done a good service in determining to make comparative trials with the four ships of the Drake class all fitted with propellers of varying proportions. We have had comparative trials before, as, for instance, with the Powerful and Terrible. But there the form of propeller as well as its pitch differed. In the ships of the Drake class the propeller is the same, and is that evolved as the result of tank experiments; but the blades being bolted to the boss can have their pitch varied so as to increase or decrease the coarseness. With such an increase one revolution of course represents a greater forward movement; and on the trials of the Drake, where the pitch was 24 feet 6 inches, the speed of 23.05 knots was got with 116 revolutions; whereas in the case of the Good Hope the same speed necessitated the engines running at slightly over 126 revolutions, because the propellers had a pitch of only 22 feet 9½ inches. The Leviathan represented the medium course; her propellers, having a pitch of 23 feet 9½ inches, gave the ship a speed of 23.25 knots for 122 revolutions; and it is now proposed to see what results will be got from the fourth ship of the class, the King Alfred, now lying in Portsmouth Dockyard, by still further increasing the pitch of her propeller. A reduction in the revolutions is in itself desirable, as the piston speed of the Good Hope exceeded 1000 feet per minute, which is a very severe trial of the machinery; but it is thought that in addition there is increased efficiency at higher speed. The slip of the propeller was least in the case of the Drake, but this does not hold good in the trial at four-fifth power; when the speed was 22 knots, the Drake on her full-power developed 30,557 horsepower when running at 116 revolutions, and then the coal consumption was 1.83 tons per horsepower per hour. On her 30 hours' trial at 75 per cent of the power 106 revolutions gave 23,103 I. H. P., the speed working out to 22.08, which is practically the same as in the case of the Good Hope. The coal consumption was 1.8 lb. On the low-power trial at one-fifth the maximum speed proved to be practically 15½ knots for 6937 horsepower, the revolutions being then 72 and the coal consumption 1.72 lb. per horsepower per hour.—*United Service Gazette*, July 19, 1902.

An American Return of the Navies of the Great Powers.—It might be truly said that of the making of records of the comparative power of navies there seems no end, but it is seldom that an official record is obtainable of the same interest as that prepared by the United States Naval Bureau for information supplied by their extensive staff of naval attaches in foreign countries. From this it would appear that the total fleet of Great Britain to-day, excluding vessels now building, is made up of 578 vessels, whose displacement tonnage is 1,583,005 tons. France comes second with 388 vessels of 634,870 tons, while the Russian fleet of 277 vessels of 462,315 tons brings the total tonnage of the two Powers to only two-thirds of that of the total British fleet. Even if Germany's ships, numbering 242 and displacing collectively 359,135 tons, were added, we should still excel the collective total of the three greatest European Powers. The United States numbers on its list 107 vessels of 303,825 tons, Italy 210 vessels of 279,815 tons, Japan 152 vessels of

251,100 tons, and Austria 114 vessels of 122,160 tons. The same preponderance in favor of Great Britain is established when the vessels building are taken into consideration, for here we have 105 ships of 433,020 tons, while France, with a large fleet of very small craft, has a total of only 181,130 tons for 90 vessels, Russia is represented as building 74 vessels of 136,220 tons, Germany 20 vessels of 117,250 tons, and the United States 59 vessels of 264,015 tons. It will thus be seen that America takes second place in this respect, but when the ships built and building are combined, her place is fourth on the list. Our first-class battleships, built and building, only equal in numbers the corresponding ships of France and Russia, but they far excel in tonnage, which, after all, represents the fighting power. If our units are not more numerous, they are probably on an average more powerful. Britain has 721,300 tons of battleships, France 252,065 tons, Russia 230,375 tons, and Germany 180,782 tons. Probably the most remarkable point about the return is the fact that the United States are building more battleships than they at present possess, and their total is 211,530 tons. When the smaller battleships and coast defence ironclads are reckoned our superiority vanishes, but probably the preponderance in the first class is a more satisfactory feature. In the matter of armored cruisers we have made very great strides; our number built little more than equals the combined fleets of France and Russia, but in process of construction we have 21 against their 13, the respective tonnages building being 225,200 and 127,365 tons. Russia, however, has lately been going in for large protective cruisers, so that the difference in modern cruisers of all kinds now building is not quite so great. Another point of interest is that the ships building for Great Britain constitute a much smaller ratio to the number built than in the case of any other first-class Power. —*United Service Gazette*, July 19, 1902.

Bilge Keels for Destroyers.—Press reports state that all new torpedo-boat destroyers will be built with bilge keels. This will decrease their speed somewhat, but will result in additional comfort for their crews, and will render them safer when operating in heavy weather.

Submarines.—Five of the six submarine boats ordered have been completed, and have been subjected by the contractors to trials with most satisfying success. The speed both awash and submerged has been much increased from the performance of the original Holland; 12 knots was maintained awash and 8 knots submerged; the cleptoscope has been much improved, so these craft are no longer entirely blind. The sixth submarine is rapidly approaching completion at Vickers. She is much greater in size and possesses greater speed than the others. Her trials will be watched with the greatest of interest.

We are officially informed that the Admiralty has decided the following types of boilers for the six first-class cruisers of the 1901-2 programme now under construction:

H. M. S. Devonshire (Chatham Dockyard).—A combination of four-fifths Niclausse and one-fifth cylindrical boilers.

H. M. S. Hampshire (Sir W. G. Armstrong, Whitworth and Co.).—A combination of four-fifths Yarrow and one-fifth cylindrical boilers.

H. M. S. Carnarvon (Beardmore and Co.).—A combination of four-fifths Niclausse and one-fifth cylindrical boilers.

H. M. S. Roxburgh (the London and Glasgow Shipbuilding Company).—A combination of four-fifths Dürr and one-fifth cylindrical boilers.

H. M. S. Argyll (the Greenock Foundry Company).—A combination of four-fifths Babcock and Wilcox and one-fifth cylindrical boilers.

H. M. S. Antrim (J. Brown and C.). A combination of four-fifths Yarrow and one-fifth cylindrical boilers.—*The Engineer*, May 30, 1902.

The cruiser Terrible has recently made a new world's record for coaling ship, 2500 tons being taken on board and stowed in a little over 9 hours, a record of 270 tons an hour.

PERSONNEL.—The half yearly promotions in the British Navy were published in July. Nine commanders were promoted to be captains, and twenty lieutenants to be commanders; these promotions were made by selection; the senior commander promoted to be captain stood number 55 on the list of commmanders and was 37 years old. He entered the British Navy in 1877. The junior of the nine captains was 37 years old and stood number 125 on the commanders list. The average age of these new captains is 39 years, and the average length of service in the commanders grade is five and a half years.

Twenty lieutenants are promoted to be commanders. The ages of these officers vary between 37 years and 28 years, and length of service in lieutenants grade from 15 to 7 years. The senior of them stood number 51 on the lieutenants list and the junior number 372.

Experiments were recently made with the old British warship Belleisle as a target, apparently intended to settle questions connected with the protection afforded to a conning-tower, the results to wire net defence of gunfire, and the condition of the interior of a casemate under similar treatment. The ship was attacked by a 9.2-inch gun and a 6-inch, the range being a little over 1000 yards. In the results the conning-tower appears to have been wrecked and the wire netting rendered useless. Many precautions were taken, both afloat and ashore, to prevent unauthorized persons from learning what transpired.—*Army and Navy Journal*, August 16.

The crew of the British battleship Hood made some remarkably fine shooting at the annual prize firing from heavy guns on July 14 and 15, off Malta. Thirty-four rounds were fired from the 13.5-inch 67-ton guns carried in the turrets, with the result that 20 hits were scored. This is a percentage of 58.5 hits to rounds fired, is the best record in the British navy with guns of this caliber, and compares very favorably with the Ocean's score of 68 per cent of hits to rounds fired from the new 12-inch gun. The best shooting with the turret guns was a score of four hits in five rounds, and with the 6-inch guns a score of a hit with every one of seven rounds.—*Army and Navy Journal*, August 16.

GUNNERY IN THE FLEET, 1901.—The returns of prize firing in the fleet for the year 1901 have quite recently been published, and it is very satisfactory to note some improvement in the shooting with nearly all types of both heavy and quick-firing guns mounted in the fleet. The return will, however, bring home to the mind of every competent critic an uneasy feeling that we have still too many types of gun in use, some of which are regarded as obsolete by our gunnery officers. The

first group of ships dealt with in the Return includes thirteen battleships mounting guns of 13.5-inch and 16.25-inch caliber. The Benbow and Sans Pareil are the only two effective ships mounting the 16.25-inch gun, but this leaves eleven still armed with a weapon conspicuously inferior to the 12-inch wire gun, and seven of these were in the Channel or Mediterranean Squadrons. The Benbow's firing was greatly inferior to that of her sister ship. She obtained but one hit in seven rounds, whilst the Sans Pareil secured five hits in eight rounds, a percentage of 62.5. Rapidity of fire, combined with a high proportion of hits, was evinced by the gunners of the Hood, Royal Sovereign, and Royal Oak. The latter, the best of the group, secured thirteen hits in twenty-six rounds, each of the others making twelve hits. The general average of hits secured by this group was 35.5 per cent, as compared with 28.2 in the previous year. We come next to the twelve modern ships mounting 12-inch, Mark VIII guns. Here individual comparisons can be drawn with profit, since each ship mounts the same number of guns, and the type is constant. The general percentage of hits, 34, was only fair but this average was so far exceeded by some of the vessels as to point clearly to the possibility of general improvement under the better system of training that has come into force, conspicuously on the China station. Take, for example, the Ocean (China station), which was the best ship of this important group of modern battleships. This ship fired twenty-six rounds in the allotted time of six minutes, and secured fourteen hits. Her percentage was thus 53.84, which was very far above the general average. The Mars stands next with eleven hits, and after her the Canopus (Mediterranean) with ten hits. On the other hand, we find the Goliath (Channel Squadron) pulling down the average by obtaining only five hits in twenty-two rounds. The Return supplies no information that enables atmospheric excuses to be offered. But the general results with the 12-inch gun were fair, and show an encouraging improvement.

The Collingwood and Colossus, armed with 12-inch guns of an older pattern, are separately tabulated. Their combined average was 30 per cent of hits, an improvement of 5 per cent on the previous year. Next we have the five battleships mounting 10-inch breech-loading guns. These are the Barfleur, Centurion, Devastation, Renown, and Sans Pareil. Mounting in the aggregate seventeen of these guns, the group fired 168 rounds and secured seventy-two hits, a percentage of 42.8 as compared with 46.9 in the previous year. It is difficult to account for this decline in the average, and one suspects some special reason. Indifferent shooting in even one ship would spoil the average in so small a group. The average of the Centurion (25.7) was much the lowest, while the Devastation's average of 59 per cent was high. The Terrible's shooting with 9.2-inch guns, Mark VIII pattern, is separately tabulated, and quite worthy this honor. She secured nine hits in fifteen rounds, or 63.6 per cent. We refer to her shooting again in examining the firing with quick-firers. Lastly, under the head of heavy guns, come a group of thirteen ships of various types mounting 9.2-inch or 8-inch guns. Here, again, the average was considerably raised from 28.37 in 1900 to 38.74 last year. In all, 271 rounds were fired from thirty-one of these weapons, and the hits recorded numbered 105. The Warspite, with fourteen hits out of thirty rounds, had the best average, and the Severn, with only two hits in fifteen rounds, pulled the average down.

It is unnecessary to examine the performance of the Monarch, which mounts 12-inch and 9-inch muzzle loaders. The Hotspur may be similarly dismissed.

So we come to the quick-firing guns, of which the two types of 6-inch are the most important, being mounted in no less than seventy-one vessels. In considering the results of the practice with these guns, it will be remembered that the target is smaller, the speed of the ships higher, and the time allowed for firing only two minutes. Under these conditions the results will be admitted as being fairly creditable, both to the gunners and their officers. Taking the first group of forty-eight ships mounting the 6-inch Q. F. gun, we find that 405 guns fired 3384 rounds. The total number of hits was 1446, or a general average of 43.32 per cent, as compared with 36.9 in the previous year. A marked improvement. Captain Scott's ship, the Terrible, still headed the list, and had practically no competitor. Using twelve guns, she fired 128 rounds and secured 102 hits, a percentage of 79.6. Compare this with the general average. Two other ships, the Royal Sovereign and Astræa, did fairly. The former secured fifty-six hits in eighty-four rounds, the latter, fourteen hits in twenty-one rounds, the percentage in both cases being 66.6. The Melampus and Royal Oak also made fairly good shooting with these guns, their percentage being 63 in each case. On the other side of the shield we find the Vindictive making but three hits in twenty-eight rounds, and the Hyacinth scoring nine hits in seventy-eight rounds. But the general average of 43.3 per cent of hits was fair, and fifteen ships obtained over 50 per cent. The firing with the 6-inch Q. F. C. guns was not nearly so accurate as might be expected. Twenty-one ships mounted these weapons to the number of 167. The general percentage of hits was 25, as compared with 21.8 in the previous year. Again an improvement. The Marathon (East Indies), which was the best ship of the group, secured twenty-three hits in forty-three rounds, giving her an average of 53.4 per cent.

Lastly, there is a table giving the results of the shooting with the 4.7-inch and 4-inch guns, mounted in sixty ships of nearly all types above that of destroyer. Here the results show the shooting to be less accurate than that with the 6-inch guns, and the average is considerably lower. With so handy a gun as the 4.7-inch, it ought to be possible to obtain equally good results. The general average was 34.28 per cent of hits, as compared with 43.3 per cent with the 6-inch guns. The fire was rapid, as 322 guns discharged 3629 rounds, and secured 1244 hits. The Barfleur headed the list with 114 hits out of 159 rounds. Next ranked the Condor, which secured sixty-five hits in 107 rounds. The Centurion, mounting the same number of these guns as the Barfleur, fired only 116 rounds and secured sixty-nine hits, a performance, not bad, except in comparison with that of her sister ship on the same station. The average with these guns was badly pulled down by several ships, notably by the Dryad, Alarm, and Renard, none of which succeeded in hitting the target. Such bad shooting cannot be accounted for by unfavorable conditions of light or weather. On the whole it will be seen that the shooting of our naval gunners is improving slightly. When the system of training, which has already been adopted on the China Station with excellent results, is general throughout the fleet we may expect something better. The secretary to the Admiralty recently mentioned in the House of Commons that their lordships

recognize the merits or the system, and are taking steps to supply the Scott apparatus and models to every squadron. The cruiser Crescent, on the other side of the globe to the Terrible, is stated by Mr. Arnold-Forster to have beaten the splendid record of Captain Scott's ship, but the returns for the present year are incomplete, and will not be published until the spring of 1903. Whether the officers of the Crescent have adopted the methods of Captain Scott was not stated.—*Army and Navy Gazette*, June 16, 1902.

The editor has received the following from Yarrow and Co.:

IMPROVEMENTS IN SHALLOW RIVER NAVIGATION.—The systems of propulsion available for shallow river navigation are:

Firstly, by paddles, one being placed on each side of the vessel, which system is familiar to everyone accustomed to travel on European rivers.

Secondly, the stern wheel system, the paddle wheel being in this case placed at the stern of the hull. This plan is adopted to a large extent on the rivers of North and South America. Both these systems have the disadvantage of reduced efficiency when the vessels are loaded and consequently deeply immersed unless feathering wheels are adopted, which is a device costly to maintain in good working order. Also the weight of this class of machinery is great and the space occupied considerable as compared with a screw propelled vessel. Moreover the wheels, especially in the side wheel system are exposed to damage by floating timber, and in any case the width of channel required with a side wheeler is increased by the width of the wheels.

The ordinary screw propelled vessel is not applicable when the draft is very limited on account of the want of ample immersion for the propeller to secure efficiency. There is a third system of propulsion for shallow river navigation consisting of an arrangement of screw propeller which has been brought forward prominently of late; it combines the advantage of a large propeller combined with a shallow draft. The propeller (or propellers in the case of twin or triple screws), revolves in a tunnel formed in the bottom of the hull, near the stern. The upper part of the tunnel is considerably above the water line. This tunnel is semi-circular at the top, and dies away forward towards the midship of the vessel, and also towards the stern aft, the propeller revolving in the tunnel at its highest part, the height of the tunnel at this place being a trifle greater than the diameter of the propeller, so that its lower blades are slightly above the bottom of the boat, and therefore there is no risk of their striking the ground. When the boat is at rest the upper part of the tunnel above the water line is filled with air, the water line in the tunnel being level with the water outside, but the moment the propeller commences to revolve, the air is driven out of the tunnel and replaced by water; thus it will be seen that a propeller whose diameter is in excess of the draft of the vessel is enabled to work efficiently in a solid column of water, although not projecting below the bottom of the hull. This system has been adopted in modern times to a considerable extent, notably in a number of shallow-draft gunboats built for the British Admiralty for service in East Africa, on the Nile, and, more recently, on the China rivers. The two last gunboats of this type that have been sent out to the East bore the names of the Teal and Moorhen. For gunboats there is no doubt this system offers special advantages, but for cargo-carrying purposes, or for tow-

ing, where there may be large variations of draft, it involves a loss of efficiency when the vessel is loaded, owing to the after end of the tunnel being lower than is required at the deep draft, the rush of water from the screw striking this inclined surface thereby forming a serious drag. At the same time when the vessel is in its lightest condition it is necessary that the after end of the tunnel should terminate below the level of the water, otherwise air will gain access to the tunnel and completely upset the system, because in the event of air being admitted the propeller no longer works in solid water. Now the improvements recently introduced by Messrs. Yarrow & Co. secure considerably increased efficiency in the loaded condition of the vessel and admit of large variations of draft. The after part of the tunnel works on a hinge, so that it can be raised or lowered to suit variations in the immersion of the vessel, the after end always being a trifle below the water level. It is easy to understand with this arrangement that the minimum inclination of the top of the tunnel to suit the conditions of draft can be adopted, and the serious reduction of efficiency due to the inclined surface of the tunnel is materially diminished; when the vessel is loaded so that its draft equals the diameter of the propeller the reduced efficiency due to the rush of water striking the inclined surface of the tunnel is entirely avoided, as the after part of the tunnel would, in this case, be horizontal.

The draft light with steam up was 11 inches, and the speed 9½ statute miles an hour.

With 10 tons load the draft was 20 inches, and the speed was 8¼ statute miles an hour.

With 20 tons load the draft was 28 inches, and the speed 7¾ statute miles an hour.

Now, taking as an example an average load of 10 tons, the same power is required with the flap lowered (which corresponds to the usual form of construction) to get 7½ miles an hour, as with the flap raised gives 8 miles an hour. That is to say there is a gain by raising the flap of ½ a mile an hour, the power remaining the same. Now assuming that the power required is proportional to the cube of the speed—which is nearly correct—the relative efficiencies will be approximately as 4 is to 5; that is to say there will be a gain of 25 per cent. It was the loss of efficiency due to the water striking the inclined surface that has probably prevented this system being more extensively adopted for vessels having variations in draft, but this difficulty it will be seen has been avoided by the present device, and Messrs. Yarrow & Co. are of opinion that for light-draft steamers this system of propulsion will probably become extensively adopted, because by this means a better combination of speed and shallow draft is obtained than by any other, together with efficiency with large variations of load.

It will be noticed that the propeller, owing to its being enclosed all round by the hull, is free from risk of damage from floating obstructions; at the same time it is readily accessible by means of a door placed at the top of the tunnel.

ITALY.

VESSELS BUILDING.

Name.	Displacement, tons.	Where Building.	Remarks.
Battleships.			
A	12,625	Government Yard, Spezia.	Building.
B	12,625	Gov't. Yard, Castellamare.	"

VESSELS BUILDING.—*Continued.*

Name.	Displacement, tons.	Where Building.	Remarks.
C.	12,625	.....	Proposed.
Vittorio Emanuela	12,625	Government Yard, Spezia.	Not yet launched.
Regina Elena	12,625	Gov't. Yard, Castellamare.	" " "
Benedetto Brin	13,526	" " "	Launched Nov. 7, 1901.
Regina Margherita	13,526	" " Spezia.	" May 30, 1901.
Armored Cruisers.			
Francesco Ferruccio	7,400	" " Venice.	" Apr. 30, 1902.
Torpedo Cruiser.			
Coatit	1,313	" " Castellamare.	Nearly completed.
Torpedo Boat Destroyers.			
Aquilone	360	C. T. T. Pattison, Naples.	Not yet launched.
Borea	360	" " "	" " "
Meteoro	360	" " "	" " "
Tuono	360	" " "	" " "
Turbine	360	" " "	Completed.
Nembo	360	" " "	"
Torpedo Boats.			
X	...	.....	Not yet ordered.
X	...	.....	" " "
X	...	.....	" " "
X	...	.....	" " "
Submarine Boats.			
.....	...	Gov't. Yard, Spezia (?)	Building.
Auxiliary Ships.			
Collier	...	.....	"
Collier	...	.....	"
Supply Ship	...	.....	Not yet ordered.

The torpedo-boat destroyer Turbine, built at Naples, has had her forced draft trials, on which a horsepower of 5306 was developed, producing a speed of over 30 knots. The revolutions were 369 per minute, and the displacement on trial 270 tons.

JAPAN.

VESSELS BUILDING.

Name.	Displacement, tons.	Where Building.	Remarks.
Protected Cruisers.			
Niitaka	3,368	Yokosuka.	Building.
Tsushima	3,365	"	"
Torpedo Boat Destroyers.			
Asashio	333	Thornycroft, England.	Nearing completion.
Asagiro	375	Gov't. Yard, Yokosuka.	Not yet launched.
Harusame	375	" " "	" "
Hayatori	375	" " "	" "
Murasame	375	" " "	" "
X	...	.....	Turbine boat; projected.
X	...	.....	" " "
X	...	.....	" " "
Torpedo Boats.			
Awataki	150	Gov't. Yard, Kure.	Not yet launched.
Hato	150	" " "	" "
Hibari	150	" " "	" "
Kari	150	" " "	" "

VESSELS BUILDING.—*Continued.*

Name.	Displacement, tons.	Where Building.	Remarks.
Kiji	150	Gov't. Yard, Kure.	Not yet launched.
Tsubame	150	" " "	" "
Hashitaka	120	Kawasaki Works, Kobe.	Ordered.
Otori	120	" " "	"
Kamone	120	Gov't Yard, Kure.	"
Sagi	120	" " "	"
Usuri	120	" " "	"
87, 88, 89	80	" " "	Nearing completion.
90, 91	83	Kobe; built at Elbing in sections.	Probably finished.
92, 93, 94, 95, 96	83	Sasebo; built at Poplar in sections.	" "
2 boats	88	Gov't. Yard, Sasebo.	" "
2 boats	88	" " Yokosuka.	Ordered.

JAPAN'S NAVY.—Writing of Japan's rise as a naval power in the *Navy and Army, Illustrated*, John Leyland says that the Japanese shipbuilding program of 1896-97 has been practically completed, and every indication goes to show that another scheme is being prepared. The program mapped out proposed to double the fleet in aggregate displacement, and to improve its quality immeasurably. Ten years was the time assigned for the consummation of the scheme (1896-1906). The total outlay was to be 192,975,473 yen upon construction and armament, and 20,328,936 yen upon buildings, torpedoes, and administration. As a matter of fact the program in its main essentials is already an accomplished work, and the time is ripe for the introduction of another scheme, which is undoubtedly in contemplation.

The main feature of the program of 1897-98 was the addition to the fleet of four battleships and six first-class armored cruisers. All the battleships have been built in England—the Shikishima at the Thames Ironworks, the Asahi at Clydebank, the Hatsuse at Elswick, and the Mikasa by Messrs. Vickers at Barrow. The last-named is of a special type, but all the vessels carry, upon a displacement approximating 15,000 tons, four 12-inch guns, fourteen 6-inch quick-firing guns, twenty 12-pounder quick-firers, and some smaller pieces, being a considerable increase as compared with the armament of the Fuji and Yashima, and they have complete armor belts, while their predecessors have side armor only between the turrets. The most interesting feature of the Mikasa, in which she differs from the others, is the disposition of the armor, and at the date of her construction it was unique. Instead of applying the scattered casemate system, these gun defences are all within the central battery, there being no unprotected space between them. There is thus complete isolation for each of the 6-inch guns, along with the provision of a continuous armorplated side for the full depth of the ship, throughout a great part of her length, ensuring an armored reserve of buoyancy and stability. This method of protection marks a considerable advance. Something like it exists in the new American ships, and Mr. Arnold Forster, in describing new British vessels in the House of Commons, in July last year, said that the separate casemate system would be abandoned, and the plan employed in the Mikasa be adopted. The Japanese ship, with triple expansion engines and Belleville boilers, steamed at 18.6 knots on her trials, the

record of any British battleship of corresponding size being exceeded. She carries 1520 tons of coal, and has a range of about 10,000 miles at 10 knots. The vessel, moreover, is fitted as a flagship, to receive an admiral and seventy officers, and has a full complement of 935 all told.

The six armored cruisers of the new program all approximate 9750 tons, and steam at from 20 to 22 knots. The Asama, which came to the Coronation review, flying the flag of Admiral Ijuien, and the Idzumo, Iwate, and Tokiwa, have been built at Elswick, while the other two have been entrusted to foreign yards—the Adsuma to St. Nazaire, and the Yakumo to Stettin. These vessels carry four 8-inch guns, fourteen 6-inch (two of them, only twelve of this caliber), twelve 12-pounders, and some smaller, the general distribution of guns being as in battleships.

The Japanese program also included several second-class protected cruisers—three was the number intended—and the Takasago has been built at Elswick, the Chitose at San Francisco, and the Kasagi at Philadelphia, while more recently the Niitaka and Tsushima, somewhat smaller, have been put in hand in Japan. There are also some torpedo gunboats. In regard to destroyers, the program has been exceeded, and twenty of them are built or building, as well as many torpedo boats; but a torpedo depot ship of 6750 tons, which was in the scheme, appears to have been abandoned.

A force therefore to be reckoned with is the Japanese fleet. In numbers it may be accounted equal to that of Italy, in quality far superior, for no completed ships in the world can, this writer believes, excel the battleships and armored cruisers of Japan. Her officers possess scientific attainments not surpassed, and qualities of courage, endurance, and resource which have stood the test of war. Those who have seen the crews of Japanese ships know that there is no finer material in the world. The establishments ashore, though yet incomplete, are admirable in efficiency, and the training establishments have won the admiration of all who are acquainted with them.—*Army and Navy Journal*, August 9, 1902.

RUSSIA.

VESSELS BUILDING.

Name.	Displacement, tons.	Where Building.	Remarks.
Battleships.			
X	12,900		Projected.
X	12,000		"
X	12,000		"
X	12,000		"
X	12,000		"
Slava	13,516	St. Petersburg.	Not yet launched.
Orel	13,516	"	Launched July 19, 1902.
Kniaz Suvaroy	13,516	"	Not yet launched.
Borodino	13,516	"	Launched September 8, 1901.
Imperator Alexander III	13,516	"	" August 3, 1901.
Tsarevitch	12,900	La Seyne, France.	" February 23, 1901.
Kniaz Potemkin Tavricheaky	12,585	Nicolaiev, Russia.	" Oct. 9, 1900. Compl.
X	12,585	" "	Not yet launched.
Pobieda	12,674	St. Petersburg.	Nearly completed.
Osliabya	12,674	"	" "
Admiral Boutakov	5,000	"	Not yet launched.
X	5,000		Projected.

VESSELS BUILDING.—*Continued.*

Name.	Displacement, tons.	Where Building.	Remarks.
Cruisers.			
Bayan	7,800	La Seyne, France.	Launched June 12, 1901.
Bogatyr	6,750	Stettin, Germany.	Trials finished.
Oleg	6,600	St. Petersburg.	Building.
Kagul	6,250	Nicolaiev, Russia.	To be launched in October.
Otshakov	6,250	Lazarev, "	" " " "
X	6,375	Libau, "	.....
Vitiaz	6,375	St. Petersburg.	Destroyed by fire June 13, '01.
X	6,375	"	Injured " " "
Askold	6,000	Kiel, Germany.	Lchd. Mar. 13, 1900. Compl.
Aurora	6,630	St. Petersburg.	Completed.
Pallada	6,630	.....	" Under trial.
Diana	6,630	St. Petersburg.	" " "
X	....	Schichau, Dantzic.	Not yet launched.
Boyarin	3,000	Copenhagen.	Launched June 8, 1901.
Kalgouia	3,200	Nicolaiev.	Not yet launched.
Almaz	3,200	St. Petersburg.	" "
Jemtchug	3,200	"	Building.
Izumrud	3,200	"	"
Miscellaneous.			
Kamchatka (Collier)	7,200	"	Not yet launched.
Imperial Yacht	(?)	(?)	No recent information.
Okean	12,000	Kiel.	Launched February 8, 1902.
Torpedo Boat Destroyers.			
Bakian	350	St. Petersburg.	" August 12, 1901.
Bekass	350	"	Building.
Gorilitsa	350	"	"
Kulik	350	"	"
Perepel	350	"	"
Skvorets	350	"	"
Strij	350	"	"
Chtchegol	350	"	"
Albatross	350	"	"
Drozd	350	"	"
Diatel	350	"	"
Bezuprechin	350	"	Launched.
Givol	350	Nicolaiev.	Ordered.
Givuca	350	"	"
Giutky	350	"	"
Giarky	350	"	"
Zavidni	350	"	"
Zavetni	350	"	"
Ostotr	312	Havre.	Building.
Kefal	312	"	Launched November 28, 1901.
Pilin	240	Ijora Works, Russia.	Practically complete.
Gagara	240	" "	" "
Krocet	240	" "	Building.
Korsum	240	" "	"
Sowa	240	" "	Practically complete.
Voron	240	" "	" "
Berkut	250	" "	" "
Nyrok	250	" "	" "
Yastreb	250	" "	" "
Torpedo Boats.			
Akoula	150	St. Petersburg.	Launched August 24, 1901.
Bytchek	150	"	" " "

VESSELS BUILDING.—*Continued.*

Name.	Displacement, tons.	Where Building.	Remarks.
Keta	150	St. Petersburg.	Building.
Makrel	150	"	"
Nalim	150	"	"
Okun	150	"	"
Paltus	150	"	"
Pescar	150	"	"
Plotva	150	"	"
Sig	150	"	"
X	150	"	Ordered.
X	150	"	"
X	150	"	"
X	150	"	"
X	150	"	"
Ice Breaking Boat	(?)	Helsingfors.	Building.
Submarine Boat.			
(Kuteinikov type)	20	Kronstadt.	Ready for trial.
2d Submarine Boat	(?)	"	Ordered.

THE RUSSIAN CRUISER ASKOLD.—The Askold is one of that group of 6500-ton Russian cruisers which contains also the Bogatyr, Pallada, and Variag, with which we have already dealt. Special interest attaches to the ships of this class, in part because they are the result of competition in design, in part because they represent a solid and earnest attempt to continue a type discarded by all other nations. It is true that we have the Encounter and Challenger in hand, but these ships have neither remarkable speed, nor do they represent anything otherwise than a copy of ancient efforts. The Russian ships, on the other hand, are extremely fast—on trial, at any rate—and all embody something in the way of constructive novelties. The Bogatyr type, of which four new vessels are building in Russia, represents the application of the idea we used in the Diadem—case-mates in a protected cruiser—applied to a vessel little more than half the size. The Askold represents, as we shall presently show, if not a new idea in the application of armor, at least internal armor applied more completely than has ever been attempted before. Krupp with the Askold, the Vulcan Company with the Bogatyr, and Cramps with the Variag, were all put in competition one against the other. The prize—that of the best-liked vessel being copied in Russian dockyards—has gone to the Vulcan Company, but as the Bogatyr is as yet hardly complete, the judgment can hardly be regarded as fully final. The fact is that all three are excellent in different ways. There is not room for that all-round excellence in 6500 tons which cannot be secured in 16,500 tons. So far as they go, the Variag represents most speed and least armor, the Bogatyr most armor and (probably) least speed—the speed differences being fractional in all three cases, for all are 23-knotters by contract. The Askold is more or less a mean between the other two. The only pity is that the interest of the competition was not heightened by Elswick, which invented craft of this kind, being put to work out the same design. The horny-handed son of toil was, however, either indulging in the "engineers' strike" or making up arrears caused by that struggle at the time the orders were given out, and the Russian Government wanted to be sure of getting its ships. Such, at least, is the avowed explanation in Russia for going

everywhere except to this country. The data of the three types compared are as follows. The lengths are believed to be between perpendiculars in all cases, and the drafts mean ones:

Name.	Askold.	Variag.	Bogatyr.
Builder	Krupp.	Cramp.	Vulcan Co.
Length (p. p.)	426½ ft.	416 ft.	423 ft.
Extreme beam	49 ft.	52 ft.	52½ ft.
Mean draft	20½ ft.	20 ft.	21½ ft.
Displacement	6500	6500	6500
Guns	All carry twelve 6 in., twelve 3 in., (12-pounders), eight 3-pounders, and two 1-pounders.		
Torpedo	All carry two submerged, and four above water, of which one is in the bow, one in the stern.		
Armor—			
Deck, slopes	2 in.	3 in.	2 in.
Turrets (?)	4 in.	nil.	nil.
Casemates (4)	4 in.	nil.	nil.
Conning tower	6 in.	6 in.	6 in.
Hoists	1½ in.	1½ in.	2 in.
Funnel bases	1½ in. sloping.	nil.	2 in. vertical.
Boilers	Schulz-Thornycroft.	Niclausse.	Schulz or Dürr.
Machinery	3 sets triple expansion.	2 sets triple-expansion.	2 sets triple expansion.
Screws	3	2	2
Coal (normal), tons	720	(?) 800	720
Coal (maximum), tons	1,100	1,100	(?) 900
I.H.P	19,000	20,000	19,500
Contract speed	23 knots for all three.		

It may here be observed that the Variag is reported to draw only 20 feet maximum draft, and all the displacements probably exhibit small inaccuracies. German publications—which ought to know—credit the Bogatyr with only six instead of a dozen 12-pounders, but Russian papers give her the same armament as the others.

In the matter of general features the Bogatyr, as our readers may remember, has a turret fore and aft. Each carries a pair of 6-inch, and the forward and after 6-inch guns are also in casemates, variously stated as 3½-inch and 4-inch thick.

Our illustrations indicate the placing of the Askold's guns, those of the Variag are similarly placed, save that the amidships 6-inch are dispensed with, and the poop and forecastle guns doubled—a very unsatisfactory arrangement in a protected cruiser, as it puts two guns at the mercy of a single shell. Eight of the 12-pounders which are on the main deck in the Askold are in the Variag placed on the upper deck. The various fires are as follows:

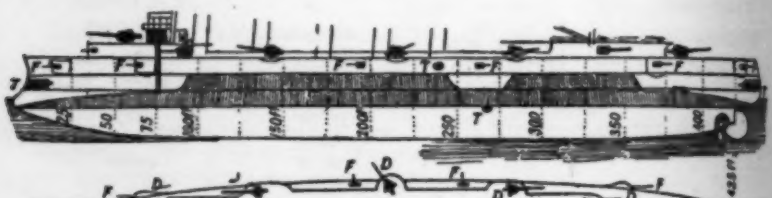
	Broadside.	End-on.
Askold	Seven 6 in., six 3 in.	Five 6 in., four 3 in.
Variag	Six 6 in., six 3 in.	Four 6 in., two 3 in.
Bogatyr	Eight 6 in., six 3 in.	Four 6 in., four 3 in.

In commenting on these, we may remark that the Variag's design exhibits most attention to serving the guns in action—a quality that shows little "on paper"—and the Bogatyr's least. Her guns are very mixed up. The Askold, having her 12-pounders all on a deck together, is, perhaps, little behind the Variag. In the matter of the best distribution the Askold is an easy first; but the Bogatyr has armor as a make-

weight, and the Variag, as already observed, is the most easily served in action.

In the matter of groups, which mean fire control in action, the ships stand thus:—Variag, two groups; Bogatyr, three groups; Askold, five groups. Since, however, the more easily they are controlled the more easily are they put out of action, it is impossible to say which is best.

The trial maximum of the Variag was 24.6 knots mean for eight hours, and 23.25 mean for twelve hours, at 16,270 indicated horsepower. The Bogatyr's trials have not yet been run. The Askold's results are as follows:—With 125 revolutions and indicated horsepower 20,390, a mean of 23.4 knots for six hours. On a second trial she did a mean of 20,420 indicated horsepower with 126 revolutions, and 23.8 mean speed. The maximum was 23,600 indicated horsepower, and 24.5 knots. Consumption on the first trial was 1.87 lb., and 1.82 on the second. The most remarkable point about the Askold's trial was a boiler test given unexpectedly, an account of which appeared in the *Marine Rundschau* last month.



The ship was to proceed on trials, but the weather being foggy, these were countermanded. She has nine boilers, and all but one were out of use. The weather clearing, she received a sudden order to put to sea at full speed, and only two hours later was doing a steady 23 knots, which presently ran up to 24.4 knots. This performance of the Schulz, as the Thornycroft boiler is now called in Germany, is very remarkable, and it is curious to reflect that in our battle of the boilers this type has not been mentioned. We, of course, have the Thornycroft in a few small cruisers; but in view of the way in which the Admiralty talk of quick steam raising in and out of season, it is certainly to be deplored that a prejudice against bent tubes should cut the record steam raiser out of the competition.

To resume: The special feature of the Askold is her deck. Instead of the usual deck, with inclined engine hatches slightly raised, the Askold has a high armor glacis to the bases of her five funnels. Whether the idea is originally Russian or "made in Germany," we cannot say, but it is distinctly good. Though all ammunition passages are now-a-days below the protective deck, there is still considerable importance attaching to the lower deck, and men with leak stoppers, &c., will have to work there in action. This big funnel glacis will go far to ensure freedom for the dense clouds of smoke and steam likely to issue from pierced uptakes. As we have so often pointed out in *The Engineer*,

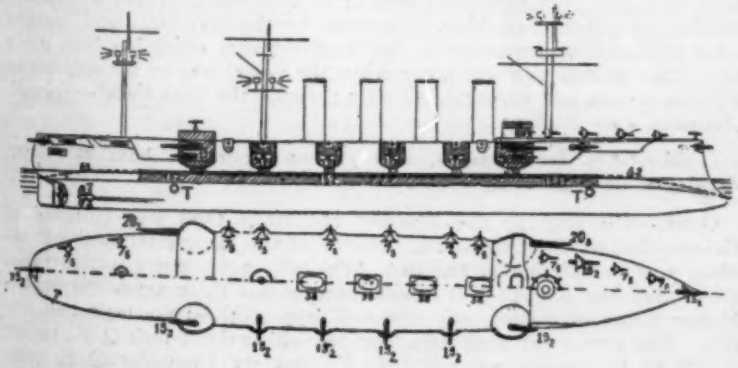
naval architects, as a class, are terribly prone to overlook all that funnels entail. We do not go quite so far as to say that a ship could be put out of action simply by holing her funnels 'tween decks, but we are none the less convinced that a ship full of smoke and steam will be quite as handicapped as a ship with several guns knocked out. Such little actual war as has taken place has already pointed one or two nasty lessons in this direction; a big war will probably give more. It took designers a long while to realize that projectiles might hit elsewhere than on big guns or the water line amidships, and we incline to doubt whether there is not as much to learn yet as has been assimilated. We give on page 658 a drawing of the Askold as she will appear when completed.—*The Engineer*, July 4, 1902.

BEZUPRECHIN.—This 350-ton torpedo-boat destroyer has recently been launched at St. Petersburg.

BOGATYR.—This 6550-ton protected cruiser, built at Stettin, Germany, has recently been under trial. For 12 hours under forced draft she averaged 24.15 knots speed per hour, and developed 20.250 horsepower.

KEFAL.—This torpedo-boat destroyer, of 312 tons, on a five hours' forced draft trial, developed 6000 horsepower and maintained an average speed of 28 knots.

THE RUSSIAN ARMORED CRUISER GROMOBOI.—Russia has always favored the armored cruiser, and she was, indeed, the first navy to put afloat any of those long, fast and powerful armored vessels which have recently become the popular and predominant type among the leading navies of the world. The *Scientific American* some time ago made its readers familiar with the Russian armored cruisers Rurik and Rossia, which so excited the interest of the British navy that a quick reply to them was made in the Powerful and Terrible. These latter vessels, however, because of their lack of side armor, would be a questionable match for the two small but better-armored Russian ships.



The Gromoboi is one of the latest of the Russian armored cruisers, and both in design and appearance is certainly a handsome and formidable-looking fighting ship. She is 473 feet in length, 68 feet 6 inches in

beam, her draft is 26 feet, and displacement 12,336 tons. Like our own Minneapolis and Columbia she is driven by triple screws, her engines of 14,500 horsepower serving to give her a speed of 20 knots an hour when everything is pushed to its full capacity. Built at St. Petersburg, and launched in 1899, she may be said to embody the very latest ideas of Russian naval designers as to what goes to make an efficient vessel of her class. She carries, in the first place, a partial belt of 6-inch steel face-hardened by the Harvey process, and her main gun positions are also protected by 6 inches of the same armor. Although the belt is not carried entirely to the bow and stern, it is associated with deck plating 3 inches in thickness, and this, of course, with its turtle-back form, offsets in some measure the undeniable weakness of the unprotected ends. The armament is carried entirely in broadside, with the exception of a bow-chaser and stern-chaser, which fire through casemates on the main deck at the stem and stern. On the upper deck, at the four corners of the central armored citadel, are four 8-inch rapid-fire guns. Forward of these, on the main deck, but outside of the citadel, are three 6-inch rapid-fire guns, one on either bow, and the third as above mentioned, mounted in the bow as a bow-chaser. There is another 6-inch gun on this deck which is mounted, as also mentioned above, as a stern-chaser, a gun port being cut for this purpose on the main deck through the stern. There are also a dozen 6-inch rapid-fire guns mounted in broadside within the citadel on the main deck, six on either broadside. The Gromoboi also carries twenty 3-inch rapid-fire guns, while several smaller rapid-fire guns are mounted on the bridges, superstructures and in the fighting tops.

The Russians are great believers in the automobile torpedo and, unlike other great naval powers, they continue to mount a large number of these on their modern ships. The Gromoboi carries five torpedo tubes, of which one is above the water-line and the other four are submerged, the Russians using a special form of submerged launching tube designed for this purpose. Another characteristic feature of this vessel is her large coal capacity, which is set down in the official list as 2500 tons of coal. This handsome cruiser is designed primarily for service in Chinese waters, and this will account for the very large coal capacity (that is, large in proportion to her displacement) which has been given her. Our photograph was taken when the vessel was on her way out to Chinese waters and preparing to pass through the Suez Canal.—*Scientific American*, July 26, 1902.

Lossos.—On recent trials, this 312-ton destroyer, built at Havre, developed over 28 knots speed.

Orel.—On July 19 the Russian battleship Orel was launched at Galerny Island, St. Petersburg. She is of the same class as the Borodino, now completing at the new Admiralty yard, and displaces 13,600 tons. She has Krupp steel armor, nine inches thick amidships, with a higher range of plating, and 6-inch Krupp steel on the main gun turrets. The armament comprises four 12-inch, twelve 6-inch Q. F., twenty 3-inch Q. F., twenty 3-pounder Q. F., and six 1-pounder Q. F. guns, with four torpedo tubes, of which two are submerged. Engines of 15,800 horsepower, supplied by Belleville boilers, are to give a speed of 18 knots. The ship had been carried more than 56 per cent towards completion, when she was launched.

SWEDEN.

A new Swedish armored cruiser is to be built within two years, at a cost of 350,000*l*. Her length will be 377.3 feet; beam, 48.9 feet; draft, 16 feet; displacement, 4060 tons; engines, 12,000 horsepower; speed, 21.5 knots; armament, eight 4.9-inch and fourteen 1.87-inch guns, and two torpedo tubes.

The 31-knot torpedo-boat destroyer Mode, built to the order of the Swedish Government, was successfully launched from Yarrow's works, at Poplar, England, on July 22, in the presence of the Swedish Minister and others.

TURKEY.

The Turkish government is beginning to take an interest in its navy. It has recently ordered:

(1) The reconstruction of six old battleships and two cruisers, at present in the Bosphorous.

(2) The construction or purchase of two modern battleships, of about 8000 tons displacement.

(3) The purchase of eight torpedo-boat destroyers, and two navy transports.

UNITED STATES.

VESSELS BUILDING (September 1, 1902.)

GIVING PER CENT COMPLETED OF TOTAL WORK REQUIRED TO BUILD THEM.

No.	Name (displacement)	Per cent completed	No.	Name (displacement)	Per cent completed
	Battleships.				
10	Maine (12,000 tons)	94	15	Georgia (15,000)	14
11	Missouri (12,500)	71	16	New Jersey (15,000)	13
12	Ohio (12,500)	62	17	Rhode Island (14,600)	13
13	Virginia (14,600)	5	18	Louisiana (17,000)	0
14	Nebraska (15,000)	0	19	Connecticut (17,000)	0
	Armored Cruisers.				
4	Pennsylvania (14,000 tons)	31	8	Maryland (13,600 tons)	2
5	West Virginia (14,000)	31	9	South Dakota (13,600)	
6	California (14,000)	12	10	Tennessee (14,500)	0
7	Colorado (13,600)	33	11	Washington (14,500)	0
	Protected Cruisers.				
14	Denver (3,100 tons)	83	19	Cleveland (3,100 tons)	86
15	Des Moines (3,100)	74	20	St. Louis (9,600)	4
16	Chattanooga (3,100)	62	21	Milwaukee (9,600)	5
17	Galveston (3,100)	64	22	Charleston (9,600)	14
18	Tacoma (3,100)	53			
	Monitors.				
7	Arkansas (3,214 tons)	99	9	Florida (3,214 tons)	94
8	Nevada (3,214)	95	10	Wyoming (3,214)	93
	Gunboats.				
	Paducah (1,050 tons)	0		Dubuque (1,050 tons)	0
	Torpedo Boat Destroyers.				
1	Bainbridge (420 tons)	99	8	Lawrence (400)	99
2	Barry (420)	99	9	McDonough (400 tons)	98
3	Chauncey (420)	99	13	Stewart (420)	90
6	Hopkins (408)	94	15	Whipple (433)	99
7	Hull (408)	94	16	Worden (433)	98

VESSELS BUILDING (September 1, 1902).—*Continued.*

Torpedo Boats.

No.	Name (displacement)	Per cent completed.	No.	Name (displacement)	Per cent completed.
19	Stringham (340 tons)	98	29	Nicholson (174 tons)	8
20	Goldsborough (247.5)	98	30	O'Brien (174)	8
27	Blakely (165)	99	34	Tingey (165)	11

Submarine Torpedo Boats.

1	Plunger (120 tons)	96	6	Pike (120 tons)	8
3	Adder (120)	99	7	Porpoise (120)	8
4	Grampus (120)	88	8	Shark (120)	8
5	Moccasin (120)	99			

THE NEW BATTLESHIPS.—The official circular defining the chief characteristics of the two battleships authorized by the act of Congress of July 1, 1902, gives the following details:

General dimensions and features of the vessels are as follows:

Length of load water line	450 feet.
Breadth, extreme, at load water line	76 feet 10 inches.
Displacement on trial, not more than	16,000 tons.
Mean draft to bottom of keel at trial displacement	24 feet 6 inches.
Gross draft, full load, about	26 feet 9 inches.
Total coal bunker capacity, about	2,200 tons.
Coal carried on trial	900 tons.
Feed water carried on trial	66 tons.

Armament—Main Battery—Four 12-inch breech-loading rifles; eight 8-inch breech-loading rifles; twelve 7-inch breech-loading rifles.

Secondary Battery—Twenty 3-inch, 14-pounder, rapid-fire guns; twelve 3-pounder semi-automatic guns; six 1-pounder automatic guns; two 1-pounder semi-automatic guns; two 3-inch field pieces; two machine guns, caliber .30; six automatic guns, caliber .30.

The above battery complete will be furnished by the government and will be mounted as follows:

(a) The 12-inch guns in pairs, in two electrically controlled, balanced, elliptical turrets, on the center line, one forward and one aft, each with an arc of fire of about 270 degrees.

(b) The 8-inch guns in pairs, in four electrically controlled, balanced, elliptical turrets, on the center line, one forward and one aft, each with

(c) The 7-inch guns in broadside, on pedestal mounts on the gun deck behind 7-inch armor, each gun being isolated by splinter bulkheads of nickel steel of from 1½ to 2 inches thick; forward and after guns arranged to fire right ahead and right astern, respectively; other 7-inch guns to have the usual broadside train.

(d) The guns of the secondary battery in commanding positions, having a large arc of unobstructed fire, and protected wherever practicable.

(e) All the 7-inch guns are so arranged that their muzzles train inside the line of the side armor, thus leaving a clear and unobstructed side when it is desired to go alongside a pier or vessel.

(f) Arrangements will be made whereby the 3-inch guns on the main deck can be quickly and conveniently dismounted, housed, and secured, all dismounting gear to be supplied by the contractor.

(g) Suitable and well-supported platforms will be provided where necessary for working the guns.

(h) All bolts for securing gun mounts and sockets will be furnished by the contractor. Such patterns of sockets, port sills, rail mounts for guns which are necessary for the installation of the mounts, or the mounting of the battery, will be supplied by the contractor. All gun mounts themselves and turret ammunition hoists will be supplied by the government, but must be installed by the contractor; all other ammunition hoists will be supplied and installed by the contractor.

(i) The full allowance of rifles, revolvers, and cutlasses for crew and marine guard will be properly stowed in armories and racks.

Turrets.—Twelve-inch and 8-inch turrets will be built and fitted complete by the ship contractor, who will furnish and install the turret structure, with shelf plates, foundations, rollers, and all turning gear, indicators, port bucklers, all hatches, watersheds, automatic shutters in wake of ammunition hoists; smoke blowers and gun-washing devices, ammunition-hoist motors and controlling arrangements, and all other fittings necessary for the proper completion and successful operation of the turrets.

Armor and Similar Protection.—The hull is protected at the water line by a complete belt of armor, 9 feet 3 inches wide, having a maximum thickness of 11 inches for about 200 feet amidships. Forward and aft of this, the maximum thickness is 9 inches within the limits of magazines, from which points the thickness is gradually decreased to 4 inches at the stem and stern.

The lower casemate armor extends to the limits of the magazine spaces and reaches from the top of the water-line belt to the lower edge of the 7-inch gun ports on the main deck, and is 6 inches in thickness, the athwartship bulkheads at the ends of this casemate also being 6 inches thick.

The casemate armor around the 7-inch guns on the gun deck is 7 inches thick, and the splinter bulkheads are from 1½ to 2 inches thick. The protection of 3-inch guns is nickel steel 2 inches thick.

The upper casemate athwartship armor extending from the shell plating to the 12-inch barbettes is to be 7 inches thick throughout.

The 12-inch barbettes extend from the protective deck to about 4 feet above the main deck, and consist of 10 inches of armor in front and 7½ inches in the rear above the gun deck. Between the gun deck and protective deck there will be a uniform thickness of 6 inches. The barbettes will not have any special framing, the connection of the armor to the decks being sufficient.

The 12-inch turrets will have a front plate 12 inches thick, rear plates 8 inches thick, and top plates 2½ inches thick.

The 8-inch barbettes will be 6 inches thick in front and 4 inches thick in rear; with the upper tube 3¾ inches thick and the lower tube 3 inches thick.

The 8-inch turret front plate will be 6½ inches thick, the rear plates 6 inches, and the top plates 2 inches thick.

The conning tower and shield will each be 9 inches thick; signal tower 6 inches thick. An armor tube 36 inches in diameter will extend from the base of the conning tower to the protective deck, and will be 6 inches thick throughout.

Teak backing of a minimum thickness of 3 inches will be fitted be-

hind all side, athwartship, and 12-inch turret armor; 2 inches of backing to be fitted behind the 8-inch turret armor; other armor will be fitted without backing.

Protective Deck.—There is a complete protective deck extending from stem to stern, the deck being flat amidships but sloped at the sides throughout, and sloped at each end. It will be built up of 20-pound plating throughout with nickel steel of 40 pounds on the flat and of 100 pounds on the slopes.

Nickel Steel Protection.—The following nickel steel is to be furnished and fitted complete by the contractor:

Upper strakes of protective-deck plating, as indicated above; hatch covers and gratings in the protective deck; splinter bulkheads on gun deck; sponsons and wing plates for two forward 3-inch guns and for four after 3-inch guns on gun deck; bullet shields between wing plates for 7-inch guns; side protection and wing plates for 3-inch guns on main deck; turret shell plates; conning-tower base plates; 7-inch gun-port sill plates; 80-pound protection on ammunition hoists trunks not otherwise protected by armor; and 80-pound protection on coaling trunks on slope of protective deck to the height of berth deck, amidships.

Cofferdams.—Cofferdams about 30 inches thick and extending from protective to berth deck level will be worked from end to end of the vessel, these cofferdams being extended above the berth deck, forward and abaft the transverse armor, to a height of about 36 inches.

The cofferdams will be packed with cellulose or other approved water excluding material. The estimated weight in detail of the above protection is as follows:

Armor and Protection.

Main belt, 192 feet long, 11 to 9 inches thick, 9 feet 3 inches deep..	686
Taper belt, first reduction, 93 feet long, 9 to 7 inches thick, 9 to 3 inches deep	254
Taper belt, second reduction, 37 feet long, 7 to 5 inches thick, 8 feet deep	66
Taper belt, third reduction, 34 feet long, 5 inches thick, 8 feet deep.	51
Taper belt, fourth reduction, 108 feet long, 5 inches thick, 8 feet deep	127
Transverse armor bulkheads in range of main belt, 6 inches thick..	14
Upper side belt and transverse bulkheads in range of same, 6 inches thick, length of side belt 284 feet	609
Casemate side armor and transverse bulkheads in range of same, 7 inches thick, length of side armor 236 feet	392
Armor for two 12-inch barbettes, 10, 7½, and 6 inches thick	560
Armor for four 8-inch barbettes, 6, 4, and 3¾ inches thick	210
Conning tower and shield, 9 inches, tube 6 inches thick	92
Signal tower, 6 inches thick	17
Four 8-inch ammunition tubes	23
Armor for two 12-inch turrets, 12-inch port plates, 8-inch side and back plates, including shelf plates, top plates, and sighting hoods.	236
Armor for four 8-inch turrets, 6½-inch port plates, 6-inch side plates, including shelf plates, top plates, and sighting hoods	224
Bullet shields for 7-inch guns, 3-inch nickel steel	15
Protection for 3-inch guns, 2-inch nickel steel	76
Splinter bulkheads, 2-inch nickel steel	68
Splinter bulkheads, 1½-inch nickel steel	72
Total	3792

Bolts	37
Backing	118
Angles, etc., fastening splinter bulkheads	17
Total	172
Cellulose	28
Armor, etc.	3792
Bolts, backing, etc.	172
Cellulose	28
Total protection	3992

Ammunition.—The magazines and shell rooms are so arranged that about one-half the total supply of ammunition will be carried at each end of the ship.

Magazine bulkheads adjacent to heated compartments, such as fire rooms, engine rooms, and dynamo rooms, are arranged with air spaces.

Ammunition Supply.—The ammunition for 7-inch and smaller guns will be conveyed by hoists directly from the ammunition rooms or ammunition passages to the deck on which it is required, or as near that as possible. These hoists will be driven at constant speed by an electric motor, and will be arranged to deliver seven pieces per hoist per minute.

The number of hoists will be as follows: Twelve 7-inch, fourteen hoists for 3-inch, 3-pounder, and 1-pounder combined, and sufficient whip hoists to the tops. To supply the 7-inch hoists, four horizontal ammunition conveyors, operated by electric motors, will be fitted in the ammunition passages for the transfer of ammunition from the handling rooms to the base of the hoists.

The turret guns have regular turret ammunition hoists, operated by electric power, these hoists leading directly from the handling rooms or the ammunition passages to the turrets. The turret ammunition-hoist motors and controlling appliances will be furnished and installed, under the specifications of the bureau of ordnance, by the contractor.

For transporting 12-inch, 8-inch, and 7-inch ammunition, trolleys and tracks will be fitted in the handling rooms, passages, and shell rooms.

Miscellaneous Ordnance Requirements.—Such battle order and range indicators and transmitters as may be furnished by the government will be installed by the contractor, who will supply and install the electric conductors and other material necessary for such installation.

The following list gives the details of ordnance weights:

Armament.	Tons.
Four 12-inch guns and mounts	329.07
Eight 8-inch guns and mounts	235.50
Twelve 7-inch guns and mounts	303.42
Twenty 3-inch guns and mounts	37.00
Twelve 3-pounder semi-auto natic guns and mounts	7.68
Six 1-pounder automatic guns and mounts	3.16
Two 1-pounder semi-automatic guns and mounts	.41
Two caliber .30 machine guns and mounts	.50
Two 3-inch field guns and mounts	1.20

	Tons.
Six automatic caliber .30 guns and mounts	.60
Small arms	1.40
Outfits, equipments and stores	25.00
Total armament	944.94
No torpedo outfit.	
240 rounds 12-inch ammunition complete	143.14
800 rounds 8-inch ammunition complete	148.57
1200 rounds 7-inch ammunition complete	159.32
6000 rounds 3-inch ammunition complete	83.97
7200 rounds 3-pounder ammunition complete	26.92
All other ammunition	29.04
Total ammunition	590.96
Ordnance weights to be carried on trial: Guns, mounts, etc.	944.94
Two-thirds full supply of ammunition	393.97
Total ordnance	1338.91

Propelling Machinery.—The engines will be of the vertical, twin-screw, four-cylinder, triple-expansion type, of a combined I. H. P. of 16,500. The steam pressure will be 250 pounds. The stroke will be 4 feet. The ratio of high-pressure to low-pressure cylinder will be at least 1 to 7, and the diameters will be sufficient for the required I. H. P. at about 120 revolutions per minute. Each engine will be located in a separate water-tight compartment. They will be provided with all the necessary auxiliaries and accessories in accordance with the latest practice of the bureau of steam engineering.

There will be twelve boilers of the Babcock and Wilcox type, placed in six water-tight compartments. They will have at least 1100 square feet of grate and 46,750 square feet of heating surface, and must be able to furnish steam for the main engines and all the necessary auxiliary machinery and other steam machinery throughout the ship with an average air pressure in the ash pits of not more than one inch of water. All the necessary auxiliaries and accessories will be provided for the efficient working of the boilers.

There will be three funnels, each 100 feet high above the base line.

Sixty-six tons of fresh water will be carried on trial in the double bottom or in reserve tanks for use of the water-tube boilers.

Auxiliary Steam Machinery.—The following auxiliary steam machinery of approved make and design, in addition to that pertaining to the main engines and dependencies, is to be supplied by the contractor and installed complete with all piping and fittings: Steering engine; windlass engine; ash-hoist engines for each fireroom; forced-draft blowers; dense-air ice plant with a cooling effect of 3 tons of ice per twenty-four hours; evaporating plant, to consist of not less than four units, having a total capacity of 16,500 gallons of fresh water per day; a distilling apparatus capable of condensing at least 10,000 gallons of water per day.

Miscellaneous Steam Engineering Requirements.—The vessel is to be heated with steam throughout, and the usual steam-heating system will be provided and installed by the contractor.

The weight of all machinery and tools, stores, and spare parts will be about 1500 tons. This weight must include all articles irrespective of name or use, coming under the cognizance of the bureau of steam engineering, including water in boilers, condensers, piping, etc., but excluding the reserve feed water in the double bottom or tanks.

Electric Generating Plant and Equipment Requirements.—The vessel shall be lighted throughout by electricity. The electric plant will consist of eight 100-kilowatt steam-driven generating sets, all to be of 125 volts pressure of the terminals, disposed in 2 separate and independent dynamo rooms. Six electrically driven generators for power supply to turret-turning motors; eleven hundred electric fixtures, complete, with necessary incandescent lamps and outlets; ten inclosed arc lamps located in engine and fire rooms, as directed; six 30-inch search lights mounted on platforms or bridges, with spare parts; two truck lights, with controller and stand complete; two electric night-signaling sets, complete, with spare parts; two diving lamps, with six outlets and eight incandescent lamps; six portable electric ventilating sets, ¼-horsepower, with spare parts; forty-five 1-12-horsepower desk and bracket fans, with spare parts; eight 1-6-horsepower bracket fans, with spare parts. Also the necessary generator switchboards, main distribution boards, auxiliary and reserve distribution boards as may be directed for the efficient operation and control of the electric plant, together with the necessary wire, wiring accessories, wiring appliances, conduit tubes and fittings, fixtures and lamps, and the instruments, tools, spare parts, and stores usually furnished for the proper manipulation, test, and repair of the plant.

Means of Interior Communication.—There will be fitted all the usual means of interior communication, such as telephones, voice pipes, call bells, buzzers, gongs, and annunciators, engine and steering telegraphs, revolution and rudder indicators, heeling indicators, automatic fire alarms, warning signals, alarm signals, etc.

The total weight of the eight steam-driven generating sets, complete, must not exceed 176,000 pounds, or 78.57 tons. The total weight of the whole electrical installation, including steam-driven generators, electrically driven generators, search lights, desk and bracket fans, portable ventilating sets, fixtures, arc lamps, switchboards, distribution boards, wiring appliances, conduit and wire for lighting, power, and interior communication circuits, with all fittings, stores, tools, and instruments, must not exceed 406,840 pounds, or 181.7 tons. The total weight of equipment outfit, complete, must not exceed 795,858 pounds, or 355.28 tons.

Ventilation.—All main compartments of the ship below the gun deck, except the coal bunkers, are to be provided with forced ventilation, there being not less than 33 blowers, with a combined capacity of not less than 104,000 cubic feet per minute. Special attention must be given to spaces subject to habitually high temperatures, such as engine rooms, fire rooms, and dynamo rooms. The ventilation system will be designed to cut the minimum number of water-tight bulkheads. All blowers, except forced-draft blowers, are to be electrically operated.

Coaling Arrangements.—The coal bunkers are to be arranged with satisfactory reference to the rapid and efficient supply of coal to the fire rooms and have a maximum capacity of about 2200 tons. There are to be provided for coaling not less than six winches, twelve booms, and all necessary fixed chutes, scuttles, hatches, and other openings.

Complement.—The vessel is designed as a flagship, and the arrangement of quarters provides ample accommodations for the following complement, viz.:

A flag officer.
A commanding officer.
A chief of staff.
Nineteen wardroom officers.
Ten junior officers.
Ten warrant officers.
Not less than 761 men, including 60 marines.

All wire or metal lockers, bag racks, ditty-box racks, hammock hooks, and miscellaneous fittings required for the complete berthing and messing of the crew, and staterooms, mess rooms, etc., for the accommodation of the officers, will be provided.

Masts.—There are steel masts forward and aft, the foremast having an upper and lower top, the mainmast a lower top only. Masts are arranged for wireless telegraphy. There is one signal yard on each mast, also a searchlight platform forward and aft, with a crow's nest on foremast.

Sheathing.—All spaces in officers' quarters on gun and main decks, bounded by the outer hull; also sick bay and dispensary also engine and fire room hatch trunks in living spaces, will be sheathed with asbestos fire felt and mill-board, or its equivalent. Asbestos sheathing will also be fitted over the engine rooms. Metal ceiling will be fitted to the outer hull in all living quarters not sheathed with nonconducting material.

The following is the summary of weights to be carried:

	Tons.
Guns, mounts, magazine equipments, etc.	944.94
Ammunition, two-thirds full supply	393.97
Steam engineering complete, with water boilers, condensers, piping, etc., and stores, etc., not to exceed	1500.00
Reserve fresh water for steaming purposes	66.00
Coal, normal supply	900.00
Boats and outfits	51.27
Masts and spars	30.98
Equipment, complete, including anchors, chains, electric plant, etc., and two-thirds equipment stores	355.28
Miscellaneous stores and water, two-thirds full supply	81.32
Provisions, clothing and small stores, two-thirds full supply	146.84
Officers, crew and effects	103.32
Total protection, including armor, armor backing, armor bolts, cellulose, and splinter bulkheads	3992.00

—*Army and Navy Register*, August 16, 1902.

The armored cruisers are to be built upon a displacement of 14,500 tons and for a speed of 22 knots, the same speed as the armored and protected cruisers recently started in construction. Their batteries will consist of four 10-inch guns, sixteen 6-inch and twenty-two 3-inch guns, twelve 3-pounder semi-automatic, and 14 rapid fire guns of smaller caliber. The 10-inch guns will be arranged two in a forward and two in an aft turret on the main deck. At either side of them, fore and aft, one of the 6-inch guns will be mounted in casement, making four in all of these guns on the main deck. On the gun deck the 6-inch guns will be arranged just as the 7-inch guns of the battleships—four on a side in

broadside and one training fore and one aft on either side. These vessels are to be 502 feet long, 72 feet 8 inches beam, and of 25 feet draft.

The plans for the two gunboats, which are also authorized by the new law, have not been completed. They will be of 1000 tons displacement and will be modeled somewhat after the Wheeling type.

MAINE.—The Maine's trial occurred July 17 with most satisfactory results. No attempt was made to force her, and she easily maintained the speed required, 18 knots, for four hours. The horsepower developed was 15,841, the revolutions averaged 128 per minute.

ARKANSAS.—This 3200 monitor had her official trials on August 9. A speed of 12.25 knots an hour was obtained with 2100 I. H. P.

BAINBRIDGE.—On her recent standardization trial this torpedo-boat destroyer averaged 28.72 knots per hour.

BLAKELY.—While having her standardization trials recently off Newport a serious accident happened to the Blakely by the breaking of the bottom of the port high pressure steam chest. Two new cylinders will be required, and it will be some months before the Blakely will again be ready for trial.

CHAUNCEY.—This destroyer was tried on the Chesapeake Bay course on August 12; the trial was most successful, 27.2 knots being maintained for the hour, with 310 revolutions. The maximum speed attained was 29.51.

DE LONG.—This torpedo boat, a sister to the Blakely, had successful trials on May 30, in Lond Island Sound. The Blakely is ostensibly of 165 tons displacement but at the time of trial she displaced 196 tons, and in commission she must displace considerably more than 200 tons. The speed required by the modified contract was at the rate of 25 knots for the mean of two runs in opposite directions over the measured nautical mile, and 24 knots to be maintained for one hour. On her trials, May 30, these speeds were easily obtained, and the boat has been delivered to the government.

DENVER.—This 3100-ton protected cruiser was launched on June 21 at Philadelphia from the yards of Neafie and Levy.

PAUL JONES, PERRY AND PREBLE.—These vessels are twin-screw torpedo-boat destroyers of about 420 tons displacement, and were built from the same general plans and specifications furnished by the Navy Department, by the Union Iron Works of San Francisco, Cal. They were four years under construction, instead of 18 months, as called for by the original contract. The modified contract required at least 28 knots to be made over the measured mile, and that a speed of at least 26 knots be maintained for one hour.

PERRY.—The Perry had her measured mile speed on April 30 when 28.32 knots was made with 370 revolutions. On May 7 the official trial of one hour was held in San Francisco Bay. The results of this trial were: Mean average revolutions for one hour, 347. Mean speed, 27.2 knots per hour. I. H. P., 8000. Displacement during trial, 471 tons.

PREBLE.—The official trials of the Preble were held on May 27. The speed made over the measured mile was 28.08 knots, with 337 revolutions per minute. The mean speed for one hour was 27.85 knots, with 335 revolutions per minute.

PAUL JONES.—The Paul Jones had her official trials on July 8. The speed made over the measured mile was 28.91 knots, with 336 revolutions, the total I. H. P. being 7819. The speed made for the hour was 27.4 knots, with 322 revolutions. For full details of the trials of these three destroyers the reader is referred to the Journal of the American Society of Naval Engineers, a most admirable publication which no naval officer can afford to be without.

WILKES.—This is a torpedo boat designed for 165 tons displacement, but on the day of trial, June 6, 1902, it was 205 tons, and under service conditions it will be 261 tons. The modified contract required her to make at least 26 knots over the measured mile, and to maintain 24 knots for one hour. On the day of trial these requirements were easily fulfilled; 25 knots was maintained for an hour, with 374 revolutions.

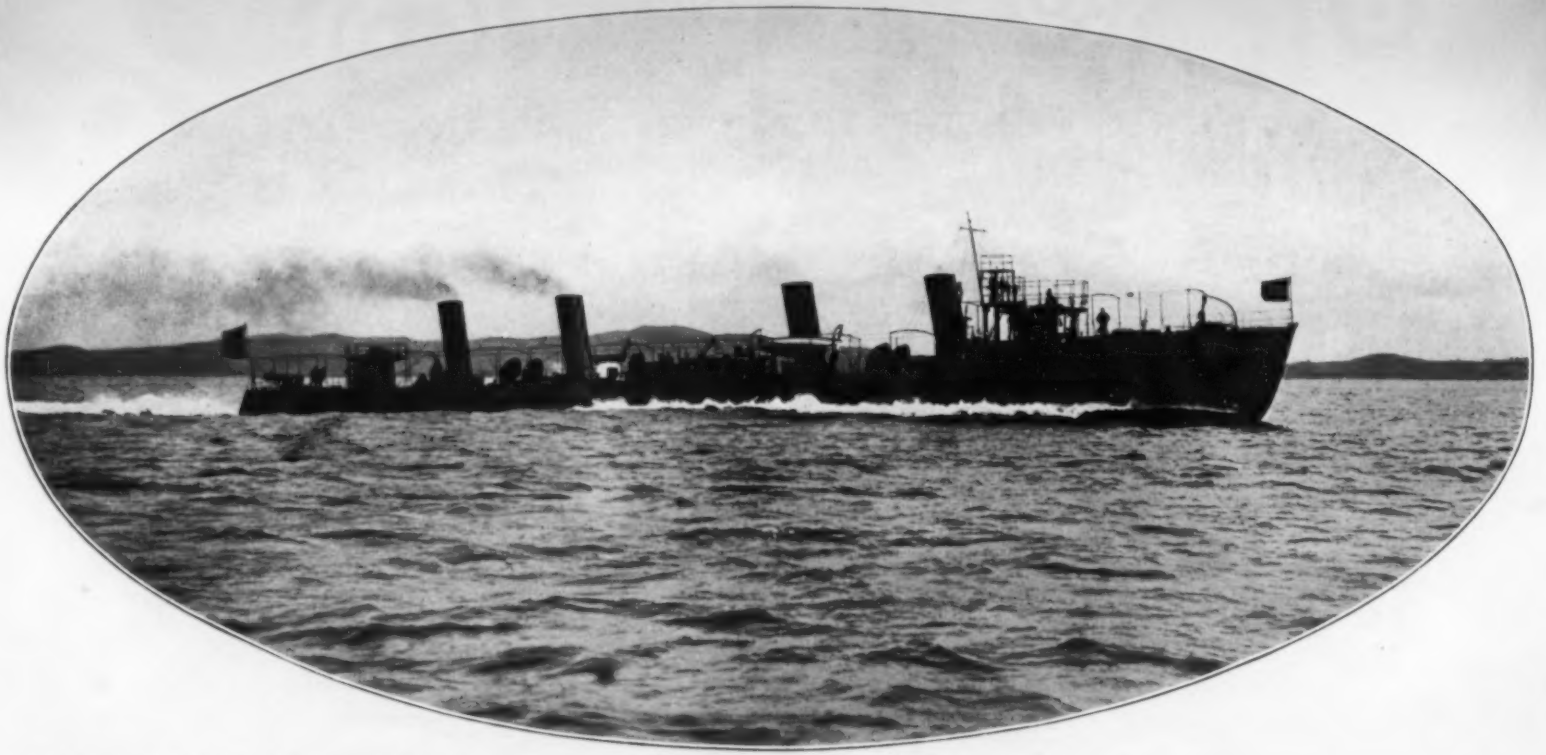
WARDEN.—This magnificent destroyer, built by the Maryland Steel Company, recently had its speed standardization trials over the Barren Island course in Chesapeake Bay, during which she made 29.86 knots.

CHARLESTON DRYDOCK.—The specifications for a drydock at Charleston, S. C., contain this general description:

The drydock structure proper and entrance to same shall be built of concrete with a granite facing and coping, and with a continuous waterproof course of felt laid in asphalt, as shown on the plans, unless during the progress of the work it is found preferable to use piles under the entire bottom of the drydock proper and entrance, or under any portion of the same. The wing walls and quay walls shall be built on piles. Included in the contract shall be all excavation, dredging, foundations, cofferdam or other temporary work, grading, crane track, including rails and switch, culvert, conduit, capstans, winch heads, bollards, cleats and everything hereinafter called for by this specification or indicated on plans, and all work necessary to render the required structures complete and in efficient working order. If it be found desirable to use piles for the foundations for the whole or any part of the drydock structure proper or entrance to same, as specified above, the same shall be paid for as provided in the specifications. The general dimensions of the drydock shall be as follows: Length at coping level from out to out (on center line), 643 feet; length at coping level from head (inside of coping) to outer sill, 600 feet; length at coping level from head (inside of coping) to inner sill, 575 feet; length at coping level from head (inside of coping) to abutment, 555 feet; length on floor from head to abutment, 528 feet; width of entrance at coping (least), 112 feet 11 5-16 inches; width of entrance at mean high water (least), 110 feet 9 5-16 inches; width at coping, in body of dock, 144 feet; width of floor between faces of bottom altars, 90 feet; depth from coping level to mean high water, 6 feet 6 inches; depth from coping level to floor at head, 41 feet; greatest depth from coping level to floor, in body, 42 feet 6 inches; depth over sill at mean high water, 32 feet; depth over keel blocks at mean high water, 31 feet; fall, on center line of floor, from head of dock to center line of culvert, 1 foot 3 inches; fall, on center line of floor, from plane of abutment to center line of culvert, 3 inches; fall from center line of dock to sides, 3 inches.—*Army and Navy Register*, August 30, 1902.

G. O. 96, Navy Department, July 9.

Upon the receipt of this order, commanding officers of vessels of the third and fourth rates will assign the pay officer of the vessel, in addi-



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tion to his other duties, a station at quarters as an assistant to the officer in charge of the powder division, except in cases where the pay officer is the senior of the two, and unless, in the commanding officer's judgment, such assignment would be inadvisable.

Pay officers so assigned shall be afforded every assistance and opportunity to learn and become familiar with their duties in the powder division, as provided in Article 633, Navy Regulations, for junior officers of division. Commanding officers will observe their progress, and shall report by April 1, 1903, to the bureau of navigation, their views, after trial, as to the advantages and disadvantages of assigning these duties to pay officers, the value of their services as powder division officers, what instruction and what length of time would be generally necessary for the acquirement of requisite familiarity with the duties to be performed.

Nothing in this order is to be considered as relieving any of the officers now charged with the execution of the requirements of G. O. 60, for the care, preservation, and inspection of smokeless powder, from any part of their responsibility for the same.

NEW NAVY RATION.—The new ration for the navy will result in a most attractive bill of fare on board all ships of war which may be in port. No one in the service ought to complain at the variety of the menu and they are not likely to. This is a sample bill of fare which prevails during the present season under the operation of the new ration:

Sunday.—Breakfast—Eggs, oatmeal and milk, bread, butter, coffee. Dinner—Roast turkey or chicken, potatoes, peas, beets or leeks, pie or ice cream, bread, butter and coffee. Supper—Cold sliced ham, potatoes, peaches or watermelons.

Monday.—Breakfast—Pork and beans, bread, butter and coffee. Dinner—Roast beef, potatoes, tomatoes, bread, butter and coffee. Supper—Liver and bacon, potatoes, bread, butter and tea.

Tuesday.—Breakfast—Beef stew, bread, butter and coffee. Dinner—Corned beef or ham, cabbage, potatoes, radishes, bread, butter and coffee. Supper—Cold roast beef, potatoes, fresh fruit, bread, butter and tea.

Wednesday.—Breakfast—Eggs, oatmeal and milk, bread, butter and coffee. Dinner—Chicken pot pie, potatoes, corn, pickles, bread, butter and coffee. Supper—Corned beef hash, jelly, fresh fruit, bread, butter and tea.

Thursday.—Breakfast—Pork and beans, bread, butter and coffee. Dinner—Vegetable soup, boiled beef, potatoes, lima beans, bread, butter and coffee. Supper—Corned beef hash, beans, bread, butter and tea.

Friday.—Breakfast—Oatmeal and milk, eggs, bread, butter and coffee. Dinner—Roast beef, potatoes, corn, fresh leeks or beets, bread, butter and coffee. Supper—Beef hash, jelly, bread, butter and tea.

Saturday.—Breakfast—Beef stew, bread, butter and coffee. Dinner—Bean soup, corned pork shoulders, leeks, bread, butter and coffee. Supper—Cold roast beef, jelly, fresh fruit, bread, butter and tea.—*Army and Navy Register*, August 30, 1902.

NAVAL ACADEMY REPORT.—Following are the recommendations of the board of visitors at the Naval Academy:

I. Buildings, Grounds, Improvements, Sanitation, Library and Finance.

1. After thorough examination of the plans for the reconstruction of

the Academy, the board reports that it approves the plans of buildings, and recommends that no change be made in them. This recommendation especially applies to the auditorium building.

In considering the expediency of building the auditorium in accordance with the existing plans already approved, the building should not be considered separately. The design for the rebuilding of the Academy has been considered and prepared as a whole, the group of Academic buildings being treated as one subject. These are arranged on three sides of a quadrangle, the basin and Severn River forming the fourth side. On the eastern or bay side have been placed the cadets' quarters. These are connected with the boat house and armory by colonnades and form a group about 1200 feet in length. On the western side of the quadrangle will be placed the power house and shops, the Academic building, and the building for the department of physics and chemistry. On the southern side will be placed the auditorium as the central building, with two small buildings flanking it, one on each side. These buildings will face toward the basin.

The auditorium is placed on the highest elevation of the grounds, and in a central position relative to the entire group. This site was selected for it and the building was designed as the predominating architectural feature. All the other buildings are comparatively low, and would without the auditorium, present a flat and depressed appearance, which would destroy the architectural features of the group as a whole. If this building be built as designed, it will give elevation to the entire group since it will be visible from all points.

2. The board recommends that investigation be made with a view to establishing an independent water supply.

3. In regard to the library, the board makes the following recommendations:

a. That a fund of $500 per year be provided for binding books.

b. That another assistant be appointed in the library to be called the cataloguer, at a salary of $1000 per annum.

c. That a special laborer now employed, be made a permanent employee as second assistant librarian, at a salary of $1000 per annum.

II. Administration, Rules and Regulations, Discipline, Drill, Practice Cruise, Police and Athletics.

1. They recommend that the designation of the members of the Academy as naval cadets be discontinued, and that the former designation of midshipmen be restored.

2. Every opportunity to investigate the condition of the Academy as to its discipline and administration was afforded and the board found the state of discipline and general management of the institution to be excellent.

3. They attended drills of all descriptions and found them excellent, but they strongly recommend that the gunnery ship and all ordnance and other appliances provided should be of the most modern types, as now used in the service, and suggest that one of the new monitors now building would make a very satisfactory gunnery ship to be used at the Academy during its sessions, and also as a part of the practice squadron.

4. They suggest that a modern practice ship is essential to the proper training of the cadets, and that a vessel with small, but modern, engines, and of about 4000 tons, be rigged as a full-rigged ship for their use.

5. They recommend that the practice cruises be always carried on under the command of the officers of the Academy.

6. They are of opinion that it would be of great benefit to the cadets if their messmen, while at the Academy, were taken from the enlisted mess men of the service in the same manner as they are now furnished while the cadets are on practice cruises.

7. Incidentally, they recommend that, in view of the increased size of the battalion of cadets, the band should be increased to the size of the present West Point Band, viz.: from 28 to 44 pieces.

8. They also recommend that, in view of the large addition to the grounds of the Academy, the number of watchmen be increased from five and a captain to eight and a captain; thus allowing two to be on duty at all times.

III. Course of Study, Standard of Scholarship and Admission and Discharge.

Under the instructions of the board, the sub-committee on the above subjects investigated, as carefully as was practicable within their limited time, the course of study, the methods of instruction and the standard of excellence in the nine departments of the Academy. To this end, Captain Wainwright, the superintendent of the Academy, and the heads of all the departments were invited to confer separately with this committee. As the result of their investigations, the committee reported the following conclusions, and these were adopted by the board:

(A) Courses of Study—Standard of Scholarship.

1. The courses of study are properly arranged in themselves and, generally speaking, with relation to each other, for the special purpose of the Academy, which is the training of cadets both in theory and in practice for the performance of their varied duties as officers in the navy of the United States.

2. The different departments are well equipped for their work with competent heads and instructors.

3. The standards of teaching are high and the methods of instruction are excellent—resulting in a satisfactory general standard of scholarship.

The board is, however, of opinion that even better results could be obtained if the teaching force were more permanent. The heads of three of the non-professional departments (mathematics, physics and chemistry, and mechanics) are professors who are not officers in the navy, and in five departments there are six civilian professors and one civilian assistant professor. All of these may be considered as having a more or less permanent tenure. All the other heads of departments and instructors are naval officers. It is very clear that the efficiency of the teaching force is lessened by the shortness of the periods for which officers are assigned for duty at the Academy.

For the ten academic years, 1892 to 1902, there have been 231 officers assigned for this duty. Of these, 23 have been twice assigned, but both assignments were not necessarily in the same department. As the number of officers for the present academic year is 48, assuming that that number has been constant, it is apparent that the entire teaching force has been changed almost five times in ten years. As the number of cadets is now larger than it was prior to 1898, it may be assumed that the teaching force is greater than it was before 1898, and if so it would appear that the changes have been somewhat more frequent than as above stated. Approximately, this gives a term of service of about two years as an average for both heads of departments and instructors (other than civilians). The average term of service, even of heads of depart-

ments, has been only about 2.41 years. The average of instructors (officers) has been considerably less than that (1.928 years). It may be noted that at the beginning of the present year the entire force of instructors (8) in mathematics were all new assignments and of these only two had previously been on duty at the Academy.

It seems clear that such frequent changes in the heads of departments are unwise. It is not necessary to give any reason for this position. It is even more true where the instructors are changed so frequently. And as to them it is obvious that an officer fresh from sea duty must require a considerable time, perhaps even a year, to familiarize himself fully with his work, and his real efficiency is hardly reached till his second year.

We believe that this condition is detrimental to the work of the Academy and that it should be corrected. We recommend:

a. That all assignments of officers for duty at the Academy should be for three years, and that this rule should especially apply to the heads of departments.

b. That assignments should be so arranged that only a portion of the detail in any department should be changed at the end of each year. The board is aware that the present condition of the navy is such as to make permanency of duty at the Academy difficult, but they still believe that greater permanency should be attained than results from the present practice, and that the good of the Academy would be much promoted if this suggestion could be carried out by the Navy Department.

(B) The committee is of the opinion that sufficient time and work are not devoted to the teaching of Spanish, a knowledge of which is now necessary for a thoroughly efficient officer in the navy. At present, the time that can be given to foreign languages is divided equally between French and Spanish. It amounts to four hours of recitation a week in the fourth class and three hours a week in the third class, with a little additional work this year in Spanish alone for the first class.

Obviously and admittedly this is not enough to give the cadets more than a slight knowledge of either language, hardly enough to form a taste for further study after graduation. As it seems impossible to divert any more time from professional studies to foreign languages, and as a slight knowledge of both of these languages has but little real value, and as, under present conditions, French is the least important of the two, the board strongly recommends that the teaching of French be entirely given up and that all the time available for foreign languages be devoted to Spanish, and farther, that the teaching of Spanish be maintained during the entire four years' course.

(C) Admission and Discharge.

Frequently cadets who have failed in their work and have been dropped from their class, have secured fresh appointments to the Academy and applied for admission to a succeeding class.

Frequently also, applicants who have failed in their admission examinations have been re-appointed and applied for admission to a succeeding class. There is nothing in the law to prevent successive re-appointments under such circumstances for several successive years, or until the appointee shall have passed the age limit of twenty years.

The board is of opinion that this practice is not beneficial, and that such re-appointments should be made only with the consent of the Academic board of the Academy. Experience shows that those who have

failed in the work of their class, or in admission examinations, are not, as a whole, sucessful in performing the work of a later class. A single instance may suffice. In the present class (1902) seventeen members had been previously examined for admission and failed. Since entering this year's graduating class, under a second appointment, 10 of these 17 have failed during the course and only seven graduate. This is below a reasonable standard of efficiency on the part of youth who are educated at the expense of the government. If the power recommended were entrusted to the Academic board cases of hardship that might arise could be met and remedied by lodging a discretion in their hands. They can intelligently deal with each case as it arises.

The board has considered the age limit of entrance. They are of opinion that the maximum age should be reduced to eighteen years. Comparatively few enter before sixteen, so that the lowest limit may perhaps be left.

Two reasons are given for making this change:

a. It is desirable that cadets should begin their work before they reach the age of seventeen, so that they may come to the active duties of the navy at about twenty-one—by no means too early an age.

b. The education in the same class, of cadets of such diversed ages, as 15 and 19, is not desirable nor beneficial to the cadets.

(D) In considering the subject of giving commissions to cadets after they have finished the four years' course at Annapolis, the committee inquired of the heads of departments how far the cadets are competent at graduation to perform the practical duties on shipboard which a commission would impose upon them. The board is satisfied that they are entirely competent for such duties. As a matter of fact, they are performing them without commissions and without adequate pay, and without a proper position in the navy. The board strongly recommends appropriate legislation in this direction.

We believe that common experience justifies the belief that the navy will be more efficient if responsibility is thrown upon officers at an early age. We believe that with proper care and selection, the naval cadets graduating from Annapolis, or certainly the best of them, may safely be entrusted with responsible duties in their profession, and that the navy will be the better if such duties are imposed upon the cadets immediately upon graduation from the Academy.

Picked American youth, as these are, mature, or can be made to mature, early, and, in our opinion, the earlier the better. It needs no argument to prove that an officer who can perform a given duty at 30 is of more value to the navy than one who has had no opportunity to learn how to do the same work till he is 35 or 40 years of age.—*Army and Navy Register*, August 7, 1902.

Rules for the Maneuvers.—The Army and Navy joint maneuvers which began last night off the eastern end of Long Island will be conducted under the following rules. These have been prepared under the direction of Major General MacArthur and Rear Admiral Francis J. Higginson, by Major George F. E. Harrison, of the artillery corps, and Lieutenant-Commander Roy C. Smith, of the navy:

General Idea 1.—Anticipating the declaration of hostilities, a strong enemy's fleet (without torpedo boats) determine to make a sudden dash upon Newport, or the eastern entrance of Long Island Sound, to secure

a naval base, taking advantage of the absence of a declaration of war to find the land forces somewhat unprepared.

Special Idea 2.—In undertaking these operations the controlling idea should be to test the training of the personnel and the efficiency of the material, and it is of paramount importance that this idea should not be lost sight of.

3. The period of the maneuvers is to be divided into two distinct phases: (a) Period of preparation; (b) period of hostility.

4. It is desirable that attacks or feints should be made all along the line, so as to test the efficiency of each part of the line, rather than to have one main attack upon some prominent point, thereby allowing enthusiasm and interest at other places to wane by a feeling of fancied security.

5. The attacks of the fleet should embrace a day attack and a night attack, and, if possible, a bombardment and a forcing of a passage.

6. This coup being made before a declaration of war, it will be assumed that prior to the period of preparation no channels are mined or obstructed; thereafter mines and obstructions may be placed.

7. During the period of hostilities the conditions are to approach those of war as closely as possible.

How to Secure Information.

8. For the Army. General features of attack on posts and the defense of same; the most efficient way for district commanders to exercise command of the defenses of artillery districts in action, including the practical co-ordination of such defenses as a whole; the use of movable armaments; the best system of fire control and direction; the practical determination of "areas of greatest advantage" for each fort; a simple and reliable method of communicating orders and information from fire commanders and battery commanders to gun emplacements; the best use of searchlights in detecting the approach of an enemy; the best location of searchlights, together with all information as to the use of same in connection with the fire of guns on ships at night; the location of range finders, and the comparative merits of depression and horizontal base systems; system of signals by searchlights between forts; the best method of conducting the work of security and information, and the utilization of commercial life saving and lighthouse stations; the practical application of wireless telegraphy and use of balloons; the number, type, caliber and mounting of guns at each fort, and the sufficiency and adaptability of same to purpose intended; type and number of emplacements, material composed of, construction, durability and strength, interior arrangements, suitability of site, plan, elevation and position with reference to other emplacements, and to enemy's guns on front, flank and rear; facilities for personnel to pass from one emplacement to another; convenience as to location of ammunition delivery tables, or the points at which ammunition is received by the cannoneers from the ammunition detail; effect of fire of guns in and about emplacements in the target practice preceding the naval attack; means of lighting, inside and out; locations and dimensions of replotting, telephone and telautograph booths; condition of rooms and galleries as to dryness; drainage and ventilation; convenience of location of armament chests, loading implements, tools, etc., and provisions made for same; efficiency of ammunition service; the condition and efficiency of all

electrical plants and appliances, including power plants, generators, storage batteries, power rooms, lamps, switchboards, motors for hoists and for maneuvering guns and carriages, electrical firing devices, and method of using cables, wires, conduits, telephones and telautographs.

9. For the Navy. The best method of obtaining the ranges of the forts and batteries fired at, the means of communicating these ranges to the division officers, the designation of the target to the divisional officers; the effect of smoke in concealing the target (as far as possible, in view of the limitations imposed by the simulated fire of the heavy guns), the order of fire in the ship considering the direction and force of the wind; the effect of mines and obstructions on the progress of the ships; for the admiral, the best method of concealing his approach; in the attack, whether it is possible to designate separate targets for the different ships after the action has begun, or to cease firing at certain batteries that he deems to be silenced, and to concentrate the fire of the ships on the remaining batteries; the method of maneuvering under fire; considering the character of the channel, the best formation to be used, the distance between ships and the speed; the efficiency of the signals used; the method of attacking in a fog, or by night; the use of searchlights for lighting the target and for blinding the eyes of the opposing gunners or range observers; whether to direct the beams at the guns or at the range-finders; whether desirable to use searchlights from all the ships or from a few, the others remaining in darkness and firing at the targets illuminated by the searchlights of the few; the method of preventing the crossing of the beams and the forming of dark sectors beyond; the blinding effect of the opposing searchlights, both on navigation and on aiming at the designated target; the possibility of shielding the eyes and looking under the beam; the methods to be adopted in forcing mined and obstructed channels.

10. A board of arbitration will be appointed to take final cognizance of the various operations of the maneuvers and to decide the results. This board shall consist of five members, two to be officers of the army, two to be officers of the navy, and the fifth to be selected by agreement of the respective army and navy commanders.

How Records will be Made.

11. The following scheme is devised to secure a complete record of all operations, which record shall serve as a basis for the decisions of a board of arbitration. First, There shall be umpires, whose powers, however, are limited, and whose main duty is to note events in the order of their occurrence. Though styled umpires, they are not to make rulings except in a few special cases, subsequently enumerated. Should an exceptional occasion arise that has not been anticipated, and that manifestly calls for a decision on the spot, an umpire may be called on to make a ruling, subject to subsequent approval by the board of arbitration. In other cases, they should make a note of any decision that seems to them justified in order to make their record more complete, but without announcing it at the time. Aboard of each ship a naval officer not attached to that ship shall act as umpire. At each fort and detached battery an army officer not attached to that fort or battery shall act as umpire. The reports of the umpires shall be made to the board of arbitration.

12. Second, there shall be observers to act with each of the forces as

representatives of the other. They shall have power to enter protests against such rulings of the umpires as are announced, and will observe and take notes in the interest of their own side. They may call the attention of the umpire to occurrences that may seem to escape his notice. Army officers shall act as observers afloat, one observer to be detailed to each ship. Naval or marine officers shall act as observers ashore, one observer, at least, to be detailed to each fort or detached battery, and two observers to Forts Adams, Wright and Terry. The reports of the observers shall be made to the board of arbitration.

13. The commanding officer of each ship, fort or detached battery shall detail a competent person as recorder for the umpire there stationed.

14. The period of preparation, as provided for in the special idea, shall be from midnight August 29 to midnight August 31.

15. The period of hostility, as provided for in the special idea, shall be from midnight August 31 to noon September 6.

16. The defense will consist of all the forts in the artillery district of Narragansett (Forts Rodman, Adams, Wetherill and Greble), and in the artillery district of New London (Forts Mansfield, Wright, Michie, Terry and the fort on Gardner's Point). They will be mobilized on a war basis, allowing two reliefs of artillerymen.

17. There will be no floating defense of any kind.

The Fifteen Vessels to Attack.

18. The attack will consist of about fifteen ships, in accordance with the following list, which is subject to revision:

A—Kearsarge.	C—*Panther.
A—Alabama.	D—Montgomery.
A—Massachusetts.	D—Mayflower.
A—Indiana.	D—Topeka.
A—*Puritan.	E—Gloucester.
B—Brooklyn.	E—Scorpion.
C—Olympia.	E—Peoria.
C—Cincinnati.	

The letters of designation used opposite the names have the following meaning: A, battleship; B, armored cruiser; C, protected cruiser; D, unprotected cruiser; E, gunboat.

19. Torpedo boats are excluded from both sides.

20. There will be required, therefore, nine army umpires and about fifteen navy umpires (depending on the number of ships).

21. A recorder for each one of these umpires will be detailed by the commanding officer of the post or ship concerned.

22. There will be required twelve navy observers, one for each of the nine forts and an additional observer for Forts Adams, Wright and Terry.

23. About fifteen army observers (depending on the number of ships) will be required.

24. The umpires and observers will assemble at the Naval War College, Newport, R. I., at 10 a. m. on August 27, to discuss the rules.

25. The army observers and navy umpires will be taken on board at Newport and distributed to their respective ships by the commander-in-chief of the naval force on August 29.

*So rated for the purposes of the maneuvers.

26. The navy observers and army umpires will assemble at Newport and be distributed to their stations by the commanding general of the shore forces on August 29.

27. Such naval militia as may be assigned to the ships will embark at Newport on August 30, and be distributed to the ships by the commander-in-chief.

28. The attacking fleet will be assembled at noon on September 6, at either extremity of the line of defense, and will then pass in review before the forts, which will salute by firing the national salute.

29. The umpires, observers and naval militia contingents will be returned to Newport on September 6, after the review of the ships, in like manner to their original distribution.

30. In pursuance of paragraph 2 of the Special Idea, it must be borne in mind that the object of the maneuvers on either side is not primarily to win, but to investigate and test certain systems and problems of attack and defense. To this end it is desirable that all units shall remain in action during the whole of the maneuvers. Hence no ship or battery will be ruled out of action by an umpire except in cases referred to in paragraph 11 of the Preliminary Details, and in paragraphs 49, 52, 53 and 57 of the rules. An umpire seldom has at any moment sufficient information on which to base a decision, and rules involving the effect and volume of fire cannot be applied on the spot, owing to lack of time for the needed calculation. In most cases it is enough if he will note his opinion without announcing it, reporting it in full to the board of arbitration. The reports of the umpires and the reports and protests of the observers and commanding officers will thus afford the basis for decisions by the board of arbitration.

When Out of Action.

31. As the ships and batteries are not to be ruled out, this circumstance must be allowed for as follows: Fire commanders will decide when, in their opinion, ships are to be considered out of action, and will communicate such decision at once to the battery commanders, who, for the rest of that particular phase, will regard such ships as negligible units. The commander-in-chief and commanding officers afloat will exercise the same prerogative in regard to batteries that they may deem to be silenced. The object of this provision is to permit the withdrawal of fire from ships and batteries that seem to be out of action and to permit concentration of fire on the remaining ships and batteries. This action must be at the risk of the responsible commander who orders it, as the final decision can be made only by the board of arbitration.

32. The attacking fleet is to be under the sole direction of the commander-in-chief of the naval force. As he is a hostile officer, he will not be given any instructions during the period of the maneuvers, nor will he hold any intercourse with the shore except under flag of truce. He will allow no boats of any kind to come alongside. If he wishes information he will seek it only as he would in war. All American merchant shipping is supposed to be in port.

33. The defense will not know more of the plans of the hostile fleet than it would in actual war. Under no circumstances shall the time be designated for any evolution or phase of the maneuvers.

34. A naval base may be established at the discretion of the commander-in-chief of the naval force; if outside the line of defense, the army cannot and is not expected to prevent such establishment.

35. There shall be no landing parties except on the government or military reservations. Plans of these reservations shall be furnished by the commanding general of the shore forces, showing the limits. During the period of hostilities flags may be established on shore to mark the boundaries of the reservation. These shall be regulation signal flags, which, being stationary and not waved, will not create confusion. The location of the flags will not be shown on the plans, but generally there will be one at each shore termination of any boundary line, and one at each pronounced change in its direction.

Charts to be Used.

36. The charts to be used in the maneuvers and in the reports will be coast survey charts No. 114, Newport to Plum Island; No. 298, Gardiner's Bay; No. 358, Fisher's Island Sound, and No. 353-2, Newport Harbor. The commander-in-chief of the naval force will supply the commanding officers of ships one copy of each of these charts for the use of umpires and observers. The commanding general of the shore forces will supply to the post commanders one copy of each of such of the charts as refer to the waters in the immediate neighborhood of their posts for the use of the umpires and observers there stationed. Any tracings required to accompany the reports of umpires, observers and other officers shall be made from these charts.

37. The commanding officers of ships shall require sextant angles or bearings, or both, to be taken at intervals of three minutes during the maneuvers in action, and at other times as may be necessary, in order to furnish later a track chart of the ship's movements.

38. On board ships R. F. guns will fire blank charges; the larger caliber guns will fire sub-caliber blanks. On shore all guns will fire blank charges. On account of the special character of the firing the rate of fire of all guns will be assumed to be that laid down in the rules for each caliber, as determined for service conditions, and will be so counted, except as hereafter provided, paragraph 58.

39. All commissioned officers of the army and navy participating in the maneuvers shall submit duplicate reports to their commanding officers embracing both a record of events and pertinent comments on all matters of professional interest that have come under their notice.

40. Full reports, embodying their own observations and the reports of their subordinate officers, shall be submitted by the commanding officers of the forts and ships to the commanding general of the shore forces (through district commanders) and to the commander-in-chief of the naval force, respectively. These reports shall be in duplicate and shall include suggestions and pertinent comments. One copy of each shall be sent by the general or commander-in-chief to the board of arbitration to guide them in their deliberations.

41. The commanding officers shall have the right of protest against any ruling of an umpire. A separate report shall be made out in duplicate in each case, the reports to follow the same course as those mentioned above.

Rules of Action.

42. Eastern standard time is to be used in all the maneuvers. The signal corps will maintain standard clocks in all the forts, regulated at noon daily, and the time aboard ships is to be regulated by chronometer.

43. Any communications between hostile forces must be made under a flag of truce. This will be indicated at night by a white flag with searchlight on it shown at a convenient point.

44. Authorized and non-combatant observers afloat will be indicated to the defense by flying the convoy flag of the navy, a white triangular flag with red border.

45. It being assumed that there is no floating defense of any sort, none of the small craft of the army employed in the service of the forts will be interfered with in any way. In view of the special character of the maneuvers, the commanding general and authorized observers may proceed from post to post unmolested.

46. Neither umpire nor observer shall interfere in any way with the handling or working of the ships or batteries. The station of umpire and observers will be, as far as practicable, with the commanding officers of ships or with fire commanders on shore, but they are free to go where their presence seems most desirable at the time.

47. The ships will not use any of the aids to navigation in their attacks (supposed for this purpose to be non-existent) unless it becomes a question of the safety of the ship, when the commanding officer will so inform the umpire on board, who will note it in his report. At night, permanent aids, such as lighthouses, may be utilized, if it be so desired, by turning on them the searchlights of the ships.

48. An umpire called on to make a ruling in special cases mentioned, paragraphs Nos. 49, 52, 53 and 57, following, and in other cases where an immediate ruling is plainly required, shall at once inform the commanding officer immediately concerned and also the observer. The observer shall protest at the time if he believes the ruling to be erroneous, also noting the protest in his report to the board of arbitration. The commanding officer may also protest and report his action as previously provided.

At the Signal Stations.

49. Signal stations will be assumed to be exposed to the same risks as in actual war. If outside the line of defense and without supports, the commander-in-chief of the naval force is justified in occupying them, destroying them, or rendering them otherwise ineffective. A cable station may be permanently put out of action by cutting the cable. A land wire station may be put out of action for twelve hours by destroying the wire and instruments. After that period it is out of action only so long as occupied by the attacking force. A flag station is out of action only while occupied by the attack. The umpire afloat must be the judge of these conditions and must announce his ruling at the time. The observer, as in other cases, has the right of protest. After an umpire has announced his decision no further messages are to be sent, or none until after the expiration of the time limit as above prescribed. If the stations have the protection of supports, an adequate force must be landed to overcome the supports, of which the umpire is to be the judge, subject to protest by the observer, as before. In case other modes of signalling are employed, the adequacy of the measures adopted by the attack will be passed on at once by the umpire on the spot, and thereafter no messages will be sent until the expiration of such time as he may determine, the observer to have the right of protest, as in other cases.

50. As one of the objects of establishing signal stations is to afford

practice to the signal corps, it is mutually agreed that during the constructive disabling of any station messages may still be sent for exercise, but that no information is to be given as to the operations or movements of the fleet.

51. Any mines placed after the beginning of the period of preparation must be fully connected and in working order. They are to contain dummy charges and dummy fuses only, but a live fuse is to be placed in the external circuit of each mine at some convenient point, for observation and inspection. In case the attacking force passes over a mine field without first clearing the channel or severing the connections, any ship that comes in contact with a mine and closes its circuit, as indicated by the blowing of the fuse in the external circuit, will be considered out of action, and will be so noted by the shore umpire in his report to the board of arbitration, but no ruling shall be made at the time. Any ship within the radius of destructive effect of an observation mine, or group of such mines, at the time the circuit is closed by the observers, shall be considered out of action on satisfactory evidence presented to the board of arbitration in the reports of the umpires, observers and responsible commanders. These reports shall show the time, the location of the ship with regard to the mines, as determined by instrumental observations on shore, checked by the ship's plotted course, and shall state the weight and character of the explosive charge in the mines.

Constructive Obstructing Only.

52. Channels are allowed to be obstructed after the beginning of the period of preparation. This, however, is to be done only constructively. It is assumed that under the conditions of war, during the period of preparation, a number of hulks of varying dimensions, the number not to exceed what might reasonably be obtained during the two days of preparation, may be sunk in selected positions in the field of maneuver. On or before August 27, the naval commander will be furnished sketch maps and memoranda, sealed, and showing the proposed locations and the character of the hulks. There shall be fifteen copies of this information in separate sealed packages. Before the maneuvers begin each umpire afloat shall be provided with one of the sealed packages. He shall consider all naval operations in the light of this secret information, and as steps are taken by vessels to investigate channels he shall release reasonable information as to the state thereof with regard to obstructions. The umpire must report all the circumstances for the decision of the board of arbitration.

53. A scout attempting to gain information by running the batteries in the daytime, as in a fog, will be considered out of action, and will retire, if, in the judgment of the umpire on shore, she has been seen in time, and has received enough fire to put her out of action. A flag signal to this effect will be made to the ship by the army and navy code. If, owing to weather conditions, no signal is seen, or the signal cannot be made out, and the umpire on board nevertheless believes that the ship has received sufficient fire to put her out of action, he will so rule; when she shall retire as before. If at night, the signal to be made by the shore umpire will be one or more red Very lights, or the equivalent, fired in the direction of the scout, which shall retire at once with all lights burning. The umpire on board will make the ruling, if the weather conditions warrant it, as in the daytime. The ship ruled out

shall take no further part in that phase of the maneuvers. Records of times, shots fired, effect of searchlights and other points shall be made by both umpires, and the observers may exercise the right of protest.

54. As some of the principal objects of the maneuvers are the testing of the fire control, fire discipline, rapidity of fire, value and accuracy of range finders, and the handling and effect of searchlights, particular attention shall be paid by the umpires and observers to the workings of these systems. The efficiency or defects in the workings of any or all of these will be noted and commented upon in their report.

Effect of Searchlights.

55. The effect of searchlights upon gun fire or upon the navigation of the ships cannot be indicated by an arbitrary rule. From all the available reports, the board of arbitration will decide the effect and estimate its value in points to be counted against the life of the battery or ship as assigned by the rules.

56. A ship blinded or wishing a searchlight turned off her conning tower or bridge shall blow a long blast of the whistle. The beam of the light must be turned to the after part of the ship immediately. If she is still inconvenienced in her navigation, she shall blow two long blasts of the whistle, when the light must be turned off that ship altogether. The times and other points of value are to be noted on both sides.

57. In an attack upon an intrenched position ten times the number of the defenders of such position actually engaged shall be required to take it, and the casualties suffered by the assailants shall be twice the whole number of the defenders. The two umpires on the spot shall decide. If one only is present, he shall decide, after conference with the two commanders.

58. In estimating the effect of gunfire, the number of shots fired under the practice conditions of the maneuvers shall not be considered to exceed the average rate of fire for each caliber as determined under service conditions from reports of target practice. If the number falls below this rate, or in case of any accident to gun mechanism or in the service of ammunition the rate is reduced below the normal average, then the actual number of fires is to be counted. The following table affords an approximate rate of fire for guns of both services. It is as nearly correct as it can be made with information now available. It will govern during the maneuvers subject to modification by the board of arbitration in their discretion, and in the light of subsequent reliable data. Small R. F., 6s.; 4-inch R. F., 15s.; 4.7-inch R. F., 20s.; 5-inch R. F., 20s.; 6-inch R. F., 30s.; 8-inch B. L. R., 105s.; 10-inch B. L. R., 120s.; 12-inch B. L. R., 150s.; 12-inch B. L. M., 180s.; 13-inch B. L. R., 180s. Guns of old types are to have their actual fires counted, to which values are to be assigned as the board of arbitration may decide.

To Value Gunfire.

59. The following rules for the value of gunfire will govern, subject to modification by the board of arbitration, as in the case of the rates of fire. They are based on these general ideas: The navy guns have from 85 per cent to guns at similar targets, according to the range. The value of hits is proportional to the striking energy of the projectile and

decreases with the value of the protection afforded by the target. The angle of fall affects the extent and vulnerability of target, both of ships and forts. The angle of presentment affects the value of the hit. A ratio exists between the vulnerable targets presented by ships and batteries at various ranges. Shore batteries cannot be destroyed by ships except by an overwhelming fire, but they may be temporarily silenced. A certain number of shots of a given caliber will destroy a ship, silence her R. F. and auxiliary batteries, or destroy or silence a single gun, depending on the vulnerability and size of target presented. Combining all the above, each shot fired may be assigned a value in points, and ships and batteries may be assigned a life in points. Also the rate of fire per minute necessary to silence a gun or battery admits of estimation in points. The tables are self-explanatory. They give the value of each shot fired, in view of all of the above considerations. The life of ships, batteries and accessories is estimated for day conditions. Their life at night is assumed to be greater, and this has been allowed for by assigning a night value in points rather than by reducing the value of each shot fired, which would necessitate new tables. By night is meant after daylight, when guns cannot be sighted except by the aid of artificial light. A distinction is made between silencing and destroying forts and ships. All shots fired count against the life of the forts or ships. If the rate of fire per minute from ships' guns reaches a certain limit, the guns fired at are silenced for that minute. Similarly the rapid fire and auxiliary batteries of ships may be silenced by a certain rate of fire per minute from the forts. A single proviso is made for obvious reasons. The value of fire in points delivered by guns of six inches and lower calibers shall not be counted against the life of the opposing ships or forts except in co-operation with the higher caliber. Without such co-operation, they count in silencing, but not in destroying.

Life of Shore Defenses in Points.

	Day.	Night.
One 12-inch barbette gun	3,400	4,100
One 8, 10 or 12-inch disappearing gun	6,800	8,200
One 6-inch disappearing gun	5,600	6,700
One battery, 6-inch or less, barbette (usually two guns)	2,700	3,240
*One battery, 6-pounders, or 5-inch siege (movable)	2,300	2,800
Position finder tower	2,800	3,400
Searchlight, in operation	3,800	4,600

A mortar battery cannot be destroyed by gunfire.

Life of Ships in Points.

	Day.	Night.
A—Battleships	1,000	1,200
B—Armored cruisers	500	600
C—Protected cruisers	350	420
D—Unprotected cruisers	200	240
E—Gunboats	100	120

* In the case of movable armaments any number of guns constitute a battery, if within 200 feet of each other and without traverses, or within 100 feet of each other and with traverses.

To Silence Guns, Ashore and Afloat.

(Points per Minute.)

	Day.	Night.
One disappearing gun (any caliber)	600	720
One 12-inch barbette gun	300	360
One battery, 6-inch or less, barbette	300	360
One battery, movable armament	250	300
Rapid fire and auxiliary batteries of a ship	450	540

Mortar batteries cannot be silenced.—*Army and Navy Register*, August 30, 1902.

Cost of Navy in Philippines.—In a report replying to a request from the House of Representatives for information, Paymaster-General Kenny says:

The total expenditures on account of the navy in the Philippines for the period stated aggregate approximately $6,209,211.84, divide about as follows:

Pay of officers and men	$2,508,574.47
Rations	526,330.50
Coal purchased on station	362,300.00
Coal and transportation of same sent from United States	914,723.86
Miscellaneous supplies and services procured by pay officers of vessels on the station	536,700.00
Labor and material at naval station, Cavite	406,400.00
Charter of the City of Pekin in May, 1898, for shipment of relief supplies, Mare Island to fleet	120,000.00
Lumber, machine tools, and supplies shipped from United States	100,000.00.
Expenditures of ammunition and ordnance material, including cost of ammunition in battle of Manila Bay	220,000.00
Purchase of the refrigerating supply steamer Culgoa, with cargo fresh provisions and coal	265,000.00
Cost of repairs and outfits for 3 gunboats sunk in the battle of Manila Bay, afterwards raised and sent to Hongkong to be fitted out	265,000.00
Total	$6,209,211.84

In addition to the above there were expenditures in the month of April for two vessels and cargoes of coal and supplies in preparation for possible operations against the Philippines, as follows:

Nashan	$155,728.00
Zafiro	87,597.00
Coal and supplies	93,097.91
Total	$336,422.91

which, added to the expenditures after May 1, as above stated, makes a grand total of $6,545,634.75.

The Bureau would add further, however, that of the total expenditures above reported, from $4,250,000 to $4,500,000 for pay, rations, coal,

expenditures of ammunition and supplies, and other general expenses of maintaining the fleet in commission are of a general character and would have been incurred regardless of the Philippine situation had the same fleet been maintained elsewhere.

It will also be proper to add that in making this statement the matter of deterioration is not taken into consideration.

So far as the navy is concerned, therefore, its increased expenditures because of the conditions existing in the Philippines since May 1, 1898, will not exceed from $2,000,000 to $2,250,000. For this additional expenditure we have six additional useful vessels and other valuable property at the naval station, Cavite.—*Army and Navy Journal*, June 7, 1902.

Rules Regarding Examinations of Candidates for Appointment in the Corps of Civil Engineers of the Navy.

Navy Department, Washington, July 26, 1902.

1. The following rules are adopted governing appointments to the corps of civil engineers in the navy:

2. No person shall be appointed who is less than 27 or more than 35 years of age.

3. Candidates for appointment shall be examined as to their physical fitness by a board of medical officers of the navy, and as to their mental and professional qualifications by a board of such officers as the Secretary of the Navy may designate for the purpose.

4. The physical examination shall precede the mental and professional, and if a candidate is found physically unfit for appointment he shall not be further examined.

5. Applications for permits to be examined must be made to the Secretary of the Navy. Each applicant must present testimonials as to character, evidence of American citizenship, evidence of having received a degree in the civil engineering course of some professional institution of good repute, and a record of at least five years' practical experience as a civil engineer and three years' responsible charge of work.

6. The mental and professional examination will be competitive, and in writing, and will comprise the following subjects: Testimonials and adaptability; English grammar and composition; elementary physics; elementary geology; drawing; arithmetic; algebra; geometry; trigonometry; analytical geometry; differential and integral calculus; applied mathematics, including mechanics and solids and fluids and strains in structures; construction materials; engineering constructions, such as workshops, chimneys, steam and electrical machinery, quay walls, wharves, drydocks, sewers, yard railways, pavements, water distribution, foundations, etc.; surveying (topographical, trigonometrical, and hydrographical) and mapping; instruments, their use and adjustments.

7. Candidates who pass satisfactorily will be arranged by the board in the order of their relative merit as determined by such examination; but no candidate will be considered as having passed a satisfactory examination who does not attain a general average of 75 per cent, and an average of at least 80 per cent in the following subjects: Applied mathematics, constructional materials, and engineering construction.

8. Examinations will be held on September 29, 1902, at the Civil Service Commission rooms, Post Office Building, Chicago, Ill., and at the navy yard, New York, N. Y., and candidates to whom permits may be

issued should present themselves before the medical officer or board at those places at 10 o'clock a. m. on that date. Candidates can elect whether they will take the examination at one or the other of these places.

H. C. Taylor, Acting Secretary.
—*Army and Navy Journal*, August 9, 1902.

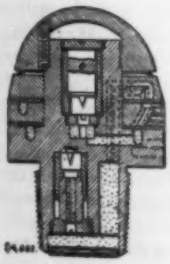
AMMUNITION.

Multi-Shot Device.—According to this invention, and in order that a following series of projectiles may be ejected from a rifle with one main propelling charge, the projectiles are caused to be separated from one another by fluid under pressure at the moment of firing. In one arrangement the projectiles have small charges of explosive between them, and means are employed to allow ignition of the small charges when the main charge is fired. Means for igniting the small charges may depend on the firing of the main charge, or can be externally controlled. In one device there are for this purpose holes through the projectiles, or there may be a channel in the wall of the breech chamber or of the cartridge case.—*Engineering*, July 4, 1902.

Shell Fuse.—This time and percussion fuse has the setting-ring attached between the fuse body and a fixed ring with concentric grooves. It operates as follows: Upon firing the gun, the lighting pellet ignites the composition in the groove or concentric arc in the

fuse body, and the fire then travels round this groove until it reaches a hole in the setting-ring and ignites the composition in the groove therein, and then travels back until it reaches a passage in the fixed ring, whereupon it is transmitted through the said ring into the fuse body through a hole, thereby igniting the powder in the powder chamber and firing the bursting charge. The fire is communicated from one groove to another sooner or later according to the position into which the setting-ring is turned.—*Engineering*, August 15, 1902.

The Cleland Davis Explosive Shell.—Following is a description of the improvement in shells invented by Lieut. Cleland Davis, U. S. N. It is taken from the specification forming part of Letters Patent No. 687,611, dated November 26, 1901:



"This invention relates to an improved form of explosive shell designed to give a maximum strength or perforating power consistent with a maximum capacity for an explosive charge.

"When the point of the projectile meets the hard elastic face of the armor-plate, there is an elastic dishing of the hard surface layer, so that the stress of impact is transmitted to the tough back, and the resistance of the whole area of depression is concentrated to oppose the advance of the projectile or materially reduce its velocity in a short space,

and thus cause it to expend its energy on itself and break up along its weakest lines. Now the logical form of projectile, so far as power of perforation goes, is the solid shot; but the destructive effect of explosive shell is such that conditions demand a projectile that will carry an explosive charge even at the sacrifice of perforating power. I have observed in a large number of experiments against armor-plate with the present form of projectile that the projectile breaks up by first upsetting or bulging in the region of the bourrelet, then giving away along longitudinal lines or in ribbon-like strips evenly distributed around the circumference of the bourrelet. Disruption along transverse lines then occurs, and the tendency to rupture is enhanced by the rotation of the projectile. Thus when the point of the projectile enters a plate the head is held fast, while the tendency of the body to continue to rotate often causes it to break in rear of the apex of the powder-cavity. From all this it would appear that the increase of the mass of metal in the walls of the shell causes the upsetting or bulging before described, when the velocity of the shell is materially reduced in a short space.

"The improvement consists, primarily, in so designing the interior or cavity of the projectile that its capacity for a bursting charge is increased, and at the same time the perforating power is increased by concentrating the weight in the line of attack. In other words the moment, and consequently the shearing tendency, of the metal in the walls of the shell is greatly reduced, and, furthermore, greater strength is given to resist the tendency of the rear end of the shell to twist off due to the rotary course when the head of the shell is embedded in the plate. The improvement is of especial advantage in cast-steel explosive shell where a bursting charge of black powder is used and in forged-steel shell with a high explosive charge or with a powder or other explosive that develops a great pressure for a relatively small charge, such as picric acid and its derivatives. The interior of the projectile is as free as possible from angles, the various connecting surfaces being curved.

"It is my purpose to cast the shell about a suitable core or cores and to machine-finish it in the usual way, or the same may be forged, if preferred.

"By this construction of shell it will be seen that the front half of the shell, where the greatest strength is required, is made very rigid and strong, and thus gives greatly increased strength for penetration, and consequently greater perforating power. Moreover, the weight may be distributed more in the front half of the shell, causing it to fly truer, on the same principle that weighted arrow-heads are used. Moreover, by having this construction thinner walls can be used and the capacity of the powder-chamber is increased for the same strength of the metal of the shell. Again, I believe that a better quality of manufacture due to the form of the shell may be secured and that this form of shell will cause it to break up into a larger number of pieces when exploded.

"The special advantages claimed for this form of shell are increased perforating power for the same weight of shell; increased capacity of the cavity, and consequently a larger bursting charge; combined with greater strength or perforating power, improvement in the quality due to its form, which makes it more susceptible to treatment from a metallurgical point of view, and improvement as regards disruption upon the

ignition or detonation of the bursting charge, whereby the shell will break up in a relatively greater number of pieces."

There is danger that in avoiding one difficulty Lieutenant Davis may run upon another. Will not the set-back of the shot on impact bulge out the rear of the shell so as to break it up if the walls are too thin?—*Army and Navy Journal*, August 30, 1902.

CAPPED ARMOR-PIERCING PROJECTILES.—Now that public attention has been drawn to the efficiency of caps on armor-piercing projectiles under certain conditions, a few remarks on the subject may not be out of place.

It may be well to discuss the general subject of penetration of plates before proceeding to the special one of capped projectiles. In former years, when wrought iron plates were attacked by steel projectiles, the latter usually remained whole, whether complete perforation was effected or not, though projectiles of inferior material or design often set up considerably in doing so. But on the introduction of compound plates, where the hard steel face was welded on to a wrought iron back, the superior hardness of the face sometimes caused the projectile to break up on striking; and with the advance to Harveyed or other hardened steel faces to the plates, up to the modern Krupp cemented plates, the tendency to break up the projectile has increased faster than the projectile makers have been able to meet it by improvements in their materials.

The problem with which the artillerist is faced is to a great extent indeterminate, and has to be met mainly in an empirical and theoretical manner, as the exact cycle of events in the penetration of a modern plate by a projectile moving at a very high velocity—from 2000 to 3000 foot-seconds—is practically unknown. Apart from complete shattering of the plate, which only occurs when it is too small superficially for the projectile by which it is attacked, penetration may be effected by punching or boring, the former being the most common, though connected by insensible gradations with the latter. In the extreme cases punching is effected not by the driving out of a cylindrical plug, as in the engineering acceptance of the meaning of the term, but by the removal of a more or less conical or mushroom-shaped portion of the plate, usually designated a disc, which is approximately of the diameter of the projectile on the face, and two or three or even more times as great on the back. The face of the disc presents a central depression, usually cup-shaped and almost hemispherical, but sometimes sub-conical, and in extreme cases the central cylindrical portion is partially punched through the disc. It would appear as though the latter action occurred early in the cycle of events constituting perforation, as the complete removal of a cylindrical plug appears never to be accompanied by the removal of the disc, the yielding of the plug removing the strains which tend to the separation of the disc, thus localizing the action. This punching action, in the limited application of the word, is not always clearly defined, the plug not always being recoverable after the perforation of the projectile. When it is found it usually has a considerable quantity of the head of the projectile in a disintegrated form welded on to its face, often to a thickness of several inches, but in other cases the plug is shattered and only recoverable in fragments, and it becomes difficult to determine whether the perforative action of the projectile

has been by punching or by that action which, for the want of a better term, we have called boring.

When the projectile first strikes the plate the whole energy is delivered by the extreme point, and in most cases the latter is completely crushed out of recognition, the head of the projectile assuming a roughly hemispherical form, though in cases of oblique attack the extreme point for a length of ½ inch to 1 inch is sometimes recovered broken off and undamaged, having probably parted from the rest of the projectile immediately on striking.

In order to preserve the extreme point from damage so as to assist it in delivering the full energy of the projectile at the point of impact, the idea occurred of attaching to it a cap of soft, but tough, steel. Such caps are either cylindrical in form, or may follow the ogive of the point, and are attached by various methods, mechanical or magnetic, most of which form the subject of patents.

Just as the precise cycle of events which takes place in the perforation of a plate is not clearly known—for example, to what extent the plate backing springs on being struck, or at what stage the disc or plug yields, or the projectile breaks up—so the exact nature of the assistance which the cap affords is the subject of much discussion. Its primary action is doubtless that it holds the point together sufficiently long to enable a much greater proportion of the energy of the projectile to be delivered on the plate than is the case with an uncapped projectile, but it no doubt also acts as a lubricant, not only for the passage of the projectile in he direction of its axis, but also for its rotary motion, the stresses due to which are doubtless very considerable when the head becomes welded into the plate, while the rotation of the body tends to continue. So long as the projectile holds together this rotary stress can have no effect on the perforation, but it is one of the stresses which breaks it up, an action which it is desirable to prevent or postpone as long as possible.

The use of a cap also has been supposed to affect the time element, by delaying the breaking up of the head of the projectile so that the plate yields before the projectile, but we venture to think that this also has an adverse effect on the body, which derives no benefit from the cap, and which, if given time, may set up or break before the maximum of energy has been delivered against the plate. The invention is by no means very recent, wrought iron caps having been tried on Palliser projectiles twenty-five years ago with a distinct promise of success, but we now appear to have fallen behind the various foreign countries in our introduction of caps, in spite of the various projectile makers' efforts to urge their use. Messrs. Hadfield, of Sheffield, have had some very successful trials, both in this country and abroad, of their capped projectiles.

The trials which have been carried out in this country by the War Department and the Admiralty have not, as a rule, been made public, but it is understood that, generally speaking, it has not been proved that any great perforative advantage has been derived from their use when the plates are attacked normally, a condition which would comparatively seldom present itself in a naval engagement, or the attack of ships from the shore, while in oblique attack a positive disadvantage has been shown. The latter objection appears to have been one that might have been anticipated. As the attack becomes more oblique,

the more important it is that the point of the projectile should bite on the plate, whereas the interposition of a comparatively soft cap must cause a tendency to slip, besides forming more of a cushion to the blow than when the plate is directly in front of the point, as in normal attack.

The efficiency of the cap undoubtedly increases greatly with the velocity. Results published in America show that the efficiency in normal attack at 2500 feet striking velocity is nearly treble that at 1900, the increased perforation at the higher velocity being about 30 per cent as compared with an uncapped projectile, whereas at the lower velocity it is only about 12 per cent. The recently published results at Eskmeals point to the same conclusion, and we venture to think that one reason our country has been slow to adopt capped projectiles has been that our trials have been carried out with velocities too low to show their advantages, but no doubt the War-office has also been influenced by that commendable caution which they always exercise in adopting any new invention before it has been thoroughly tested. Moreover, our standard armor-piercing projectile is a shell, the design of which is too weak to derive full benefit from the use of the cap, the higher work it is thereby called upon to perform tending to break it up more instead of increasing the perforation.—*The Engineer*, June 27, 1902.

ANCHORS.

THE HISTORY OF THE ANCHOR.—The ships' anchors in general use, up to the beginning of the last century, consisted of a long, round, iron shank, having two comparatively short, straight arms, or flukes, inclined to the shank at an angle of about 40 degrees, and meeting it in a somewhat sharp point at the crown. In large anchors, the bulky wooden stock was built up of several pieces, hooped together, the whole tapering outward to the ends, especially on the after or cable side.

About the beginning of the last century, a clerk in Plymouth naval yard, Pering by name, suggested certain improvements, the most important of which was making the arms curved instead of straight. At first sight, this simple change may seem of little value, but consideration will show that this is not the case. The holding power of an anchor depends on two principal conditions, namely, the extent of useful holding surface, and the amount of vertical penetration. The latter quality is necessary on account of the nature of ordinary sea bottoms, the surface layers of which are generally less tenacious and resisting than is the ground a short distance below. Now the measure of penetration, and also, to a limited degree, that of useful holding surface, is the vertical distance from the lower portion of shank to the pea, or extreme end of the arm, when fully buried. The distance evidently depends on the length and on the inclination of the arm. Some inclination the arm must have, in order to bring about penetration; yet the more at right angles to the shank, the greater the penetration. These two opposing conditions are reconciled by curving the arm to the arc of a circle having its center in such a position that the radius of the curve is about a third of the length of shank. Two minor advantages also accrue. During the process of tripping or breaking out the anchor, the buried arm continues its curved path in the ground until the shank is nearly vertical and the pea ready to emerge with the least possible

resistance. The old-fashioned straight arm, on the other hand, retained a more or less horizontal direction in the ground, until the leverage derived from the effective length of shank became very much reduced. Again, with straight arms there exists considerable resistance to penetration, because the entire anchor must move longitudinally before the arm can bury itself; but with curved arms the weight alone of shank and upper arm suffice to bury the anchor in soft bottoms without longitudinal displacement. This last consideration, which has some bearing in the case of modern stockless anchors with two blades, was again referred to when dealing with the Martin's type of anchor.

In the year 1831 chain cables began to supersede the hempen ones, with the result that the long-shanked anchors hitherto in vogue were no longer necessary, and anchors with shorter shanks and with heavier and stronger crowns gradually came into use. In consequence of these changes, a commission was appointed in the year 1838 to inquire into the holding power of anchors, and a principal result of their labors was the adoption of the so-called admiralty pattern anchor, which continued to be used in the navy up to 1860. The invention of the steam hammer in 1842 made the welding of heavy masses of iron a comparatively easy and reliable process, so that from this time onward the strength of anchors fully kept pace with that of the chain cables which had come into general use. A great number of patents for anchors were taken out prior to the great exhibition of 1851, and public attention having been called to the models there shown, in the following year a committee was appointed by the admiralty to report on the qualifications of anchors of the various kinds. Practical trials were then instituted, and, as a result, Trotman's anchor took the highest place out of eight competitors, Rodger's anchor being second on the list. Some of the tests to which the anchors were submitted were of doubtful value, such for instance, as "facility for sweeping." Nowadays, at all events for deep ships in shallow harbors, it is considered an advantage for an anchor to offer as little obstruction as possible above the ground. In this particular test, as also in some others of small importance, Trotman's anchor was handicapped as against those of ordinary form, yet it came out first owing to its undoubted superiority in holding power.—*Scientific American Supplement*, August 9, 1902.

ARMOR.

TESTS OF 6-INCH AND 7.5-INCH GUNS AGAINST 6-INCH AND 12-INCH CEMENTED (KRUPP) STEEL ARMOR-PLATES.—Table I. First, Second, and Third Rounds against 11¼-inch plate. Date: May 9, 1902. Firing at Eskmeals range for trial of 7.5-inch and 6-inch Vickers armor-piercing projectiles fitted with Johnson cap against a 12-inch Vickers K. C. plate, No. 4865.

Round 1.—Completely perforated plate. Projectile was broken up. Penetration measured 18 inches to base of shot, after removing its fragments the penetration measured 23½ inches. Extent of injury by scaling, 18.5 inches H. by 20.5 inches V. No cracks. Diameter of hole 6 inches. This shot struck exactly in front of a horizontal H. girder, and bulged it back 1⅞ inches, otherwise it would have gone completely through.

Round 2.—Projectile completely broken up. Penetration about 3¼ inches, but point of shot remained fused in plate. Extent of injury by scaling, 18½ inches H. by 19 inches V. No cracks. Diameter of portion of shot in hole = 8 inches. There was no trace of bulge at back, or any displacement of backing.

Round.	Charge. Nature.	Charge. Weight	Projectile and Fuse.	Velocity. Mean Muzzle.	Temperature of charge, 80° Fahr. Thermometer. Dry bulb 48° " Wet " 47° " Barometer, 30.25 in. S. V.	S. E.	Ramming
		lb.		ft.-sec.	ft.-sec.	ft.-tons.	in.
1	R. R. 384, Nitrocellulose.	34	Vickers 6 in. A. P. shot, fitted with Johnson cap 105 lb.	2856	2799	5705	41.65
2	Ditto.	34	Vickers 6 in. A. P. shot without cap 100 lb.	2880	2820	5513	41.55
3	Cordite $\frac{30}{50}$	43	Vickers 7.5 in. A. P. shell, fitted with Johnson cap, 205 lb.	2480	2444	8492	66.75

Round 3.—Projectile broken up, but all the point portion, including 2 inches of core, remained in plate; it was not, however, fused in as in Round 2, for a feeler could be inserted in many places round the periphery up to 7 inches from face of plate. Penetration to front end of core was 5 inches; if, therefore, the point preserved its profile, the total penetration would be 9½ inches. Base portion set up and part flowed in molten state into the front of core, moulding itself to its contour. Extent of injury, 23.5 inches H. by 21.5 inches V.

Table II. Fourth and Fifth Rounds against 11¾-inch plate. Date: May 23, 1902. Firing at Eskmeals range for trial of Vickers 6-inch armor-piercing shot fitted with Johnson cap, against a Vickers 12-inch K. C. plate, No. 4865.

Round.	Charge. Nature.	Charge. Weight	Projectile and Fuse.	Velocity. Mean Muzzle.	Temperature of charge, 80° Fahr. Thermometer. Dry bulb 55° " Wet " 54° " Barometer, 30.3 in. S.V.	S.E.	Ramming
		lb.		ft.-sec.	ft.-sec.	ft.-tons.	in.
4	R.R. 384. Nitrocellulose.	34	6-in. Vickers A.P. shot fitted with Johnson cap. Weight 100.5 lb.	2841	2786	5676	41.75
5	Ditto.	34	6-in. standard A.P. shot without cap. Weight 100 lb.	2867	2827	5542	41.7

Three rounds had previously been fired at this plate on May 9, 1902.

Round 4.—Shot completely perforated plate, but did not get through the wood backing or skin-plate. The shot remained in backing, the rear of base being 9 inches from surface of plate; a feeler could be inserted along the outside of shot to a distance of 16 inches from surface of plate. The extent of injury by scaling was 20 inches H. by 22½ inches V.

Round 5.—Shot completely broken up. Penetration 3 inches. Point of shot remained fused in plate. A large piece of shot rebounded and was found 20 feet in front of plate.

Table III. Trials against the 6-inch plate. Date: May 23, 1902. Firing at Eskmeals range for trial of Vickers 6-inch armor-piercing shot and 7.5 inch armor-piercing shell, both fitted with Johnson caps, against a Vickers K. C. plate, No. 4126, 8 feet by 6 feet by 6 inches.

Round.	Charge.		Projectile and Fuse.	Velocity.	Temperature of charge, 86° Fahr. Thermometer. { Dry bulb 89° " Wet " 64° " Barometer, 30.3 in.		
	Nature.	Weight		Mean Muzzle.			
		lb.		ft.-sec.	S. V. ft.-sec.	S. E. ft.-sec.	Ramming lb.
1	Cordite $\frac{20}{17}$, Lot 119	12.5	6 in. A. P. shot (Vickers), without cap. Weight, 100 lb.	2034	1995	2766	41.3
2	Cordite $\frac{30}{30}$, Lot 117	35.3125	7.5-in. A. P. shell, fitted with Johnson cap. Weight, 205 lb.	2221	2186	6796	66.75
	Cordite $\frac{20}{17}$, Lot 119	12.94	6-in. A. P. shot (Vickers), fitted with Johnson cap. Weight, 105 lb.	2007	1971	2829	41.8

Round 1.—Projectile broke up, point remained fused in plate. Extent of injury by scaling, 24 inches H. by 22 inches V. There were no cracks. There were signs of a bulge at the back.

Round 2.—Complete perforation took place; no pieces of shell, except the base-plug, were found. The size of hole was 8.75 inches by 8.5 inches. Extent of scaling, 14.5 inches H. by 14.5 inches V. The point of shell of this round, weighing 92 lb., was subsequently recovered, having penetrated 20 feet into sand at rear of target.

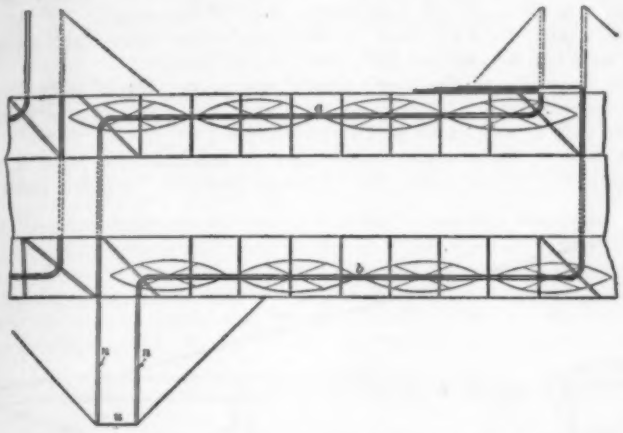
Round 3.—Complete perforation took place. Projectile broke up, pieces being found in rear. Size of hole, about 6½ inches. Extent of injury by scaling was 13 inches H. by 14 inches V.

A series of five rounds was then fired from the 7.5-inch gun at a target 1000 yards off. Starting with the gun loaded, the time to pressing trigger for fifth round was 31 seconds. All the rounds hit within a space about 6 feet H. by 5 feet V.

BOATS.

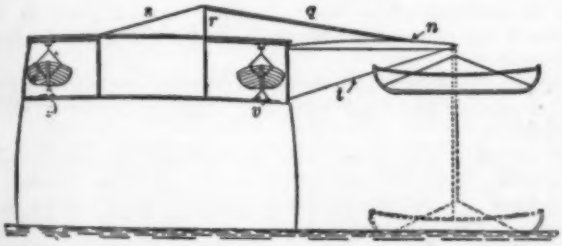
THE PETERSON BOAT-LAUNCHING APPARATUS.—In recent years very few inventions have been made in appliances for launching boats from

shipboard, whereas numerous and excellent ideas have been developed in improved lifeboats, rafts, self-detaching hooks, life preservers in different shapes, etc. However, no ship, no matter how well constructed, engined and manned is proof against accident, and no one knows at what time the ship must be abandoned, and the only means of



rescue will be the lifeboats. Admitting the great value of good lifeboats and other appurtenances pertaining to means of life saving, the fact remains that unless the vessel is fitted with an apparatus by means of which the boats can be easily launched under any existing circumstances, the safety of the lives entrusted to the ship is not assured.

Of the many improved boat davits, the most prominent is the Mallory davit, which to a great extent is being adopted both in merchant and naval vessels as superior to the old-style swinging davits. Unfortunately even the best system of davits now in use does not fulfill the



requirements, as too much labor is generally involved in manipulating it and there is too much uncertainty as to its proper working in case of emergency.

Following are the most important requirements for an efficient boat-launching device:

1. The apparatus must be so constructed that it can be worked by manual power with great ease. To depend upon steam or other arti-

ficial power is objectionable, as this may not be available when most needed.

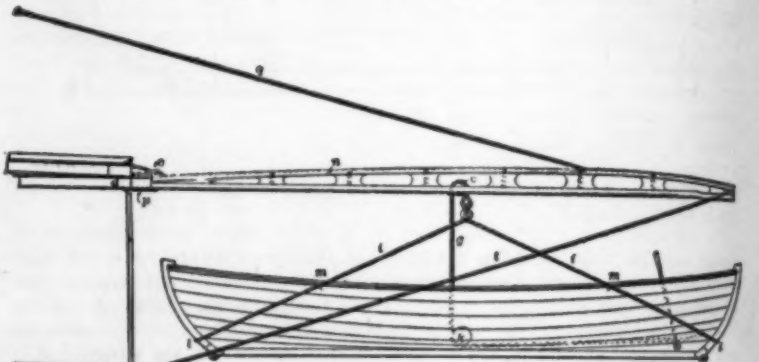
2. Boats should be so located that passengers and crew can easily get into them. Stowing of boats inside each other or bottom up, as is sometimes the case, is absolutely condemnable.

3. Boat-launching apparatus should preferably be so constructed that any boat can be launched from either side of the vessel.

4. Boats must be well clear of the vessel when they reach the water so that oars can be used on both sides of the boats.

5. The lowering of the boats should not be performed from the ship. The launching system should be such that the boats can be conveyed from the ship to the water by the boat crew.

6. As it is of the greatest importance to minimize the labor involved in getting the boats from their stowed position into the water, the



releasing appliances must be as simple as possible and boat cradles should preferably be avoided. Also boats in their stowed position should be connected with the conveying apparatus, so that they can be launched at a moment's notice.

The Peterson launching apparatus has been constructed to meet these severe requirements and care has been taken to make it with as few parts as possible.

The new system comprises two permanent overhead tracks, each having a terminus on both sides of the vessel, and four booms of built-up section forming a continuation of the tracks, when swung in position ready for use. The number of boats to be stowed on each track has to be determined by the total number carried, but it is not advisable that more than four boats should be carried on one track. In the stowed position the boats are suspended from the tracks, and kept in equilibrium by rope lashings through the keel and eyebolts on deck. Trip hooks can be used, but rope lashing is safer, as a knife, which is always handy, will release the boat in less time than a trip hook.

The permanent tracks are made of two Z bars riveted to the overhead structure. The lower flanges of these Z bars form a guide for

truck, *C*, the conveying medium for the boats. To this truck the boats are connected by two stout hemp ropes of sufficient strength passing over sheaves which are mounted on the same pin as the rollers. One end of the hemp ropes is attached to a hanger, *i*, embracing the boat and thus giving four points of support, instead of two as used in the present system, and adding to the stability. The other part of the ropes passes over a leader near the center of the boat, to a friction brake at the stern, which holds this end of the rope firmly, and when boats are to be lowered this is done by operating a lever which releases the grip on the ropes.

The second part of the launching apparatus, the booms, are pivoted at the terminus of the track and carried partly by straps, *p*, on the permanent track, and partly by the stay or stays, *q*.

Spans and guys, *u* and *t*, serve to keep the booms in position. When not in use these are folded up against the ship's side. To put the booms in position ready for launching, and releasing the boats by cutting the lashing ropes, will not require as much time as accommodating the passengers in the boats. When this latter part is done the boats are pushed along on the tracks and out to the end of the booms, from whence they are lowered from the boat itself by the use of above mentioned friction brake, controlled by one of the crew detailed for this duty.

The booms and stays are designed to safely carry the weight and are made long enough to allow the boats to clear the ship's side.

By this system the boats can be launched from either side of the vessel, as the tracks extend across from side to side. For the safe conveyance of the boats over the deck, rollers are applied at the junction of the keel and stem and stern. When the boats are lowered the free end of the lowering rope passes over the sheave and drops into the water, leaving the trucks on the boom. A recess on the outer end of the boom—which is closed—prevents the truck from rolling back. When the boat reaches the water the weight is taken off the hanger, and as this is simply laid in slots cut in the stem and stern, and guided by open eyebolts, *m*, it can be easily removed.

BOILERS.

BOILERS FOR THE NAVY.—What may, we suppose, be regarded as the final report of the Committee on Navy Boilers appointed in September, 1899, was issued on Wednesday night. We cannot say that it adds much to what has already been published. It contains, however, a clear statement of the reasons on which the Committee have based their conclusions, and an elaborate and interesting individual report by Mr. List, concerning which we shall have more to say. The result of the labors of the Committee is a fairly emphatic condemnation of the Belleville boiler. But there is more than this. Although they recommend that, as has already been set forth in our pages, the Niclausse, Babcock and Wilcox, Dürr and Yarrow large tube boilers should be fitted for experimental purposes, they are evidently far from certain that any water-tube boiler yet made is really the best generator for ships in the British Navy. The position appears to be simply, that all that ever can be known about the Scotch boiler is known. Its defects, its merits,

its peculiarities, the best and the worst way of managing it are completely understood, and there is no reason to suppose that it is quite unsuitable for use in our navy. On the other hand, at least, in so far as regards types of warships other than destroyers, the water-tube boiler must be regarded as still on its trial. Referring to trials which they say should be carried out, the Committee add that, "While they will indicate whether Yarrow large-tube and Dürr boilers are safe and efficient steam generators, the Committee do not anticipate that the results of these trials, when taken together with the trials of the Babcock and Wilcox and the Niclausse boilers, will enable them to say whether either of these boilers can be 'authoritatively recommended as a standard boiler for the use of his Majesty's Navy,' as the endurance of the boilers, the nature and extent of the defects which will be developed on actual service, the loss of efficiency after prolonged use, and the cost of upkeep, can only be determined by lengthened experience. In the ships of the Monmouth and Devonshire classes opportunity will be afforded for a very important comparison between ships of practically the same displacement and power, fitted with the same type of machinery, but only differing in the types of boilers fitted. The results obtained by these ships on trials and on actual service should contribute to a large extent towards solving the problem as to the best type of boiler for his Majesty's service."

The principal result, then, of the labors of the Committee is that no one certainly knows that any better boiler than the Scotch boiler can be used. There is reason to hope that some form of water-tube boiler will prove itself to be better; but we are not dealing now with hopes or fears, but with the existing state of that absolute knowledge that can only be obtained from continued use. Thus, for example, it is easy to say that any particular type of boiler ought not to fail by, let us say, corrosion; but no certainty can be obtained regarding this until a sufficient number of boilers has been at work for a sufficient period of time. It appears to be sound policy, under these circumstances, to regard the use of the water-tube boiler as purely experimental. To adopt any individual type extensively would be to repeat the Belleville mistake. But the Admiralty are thus placed in a very peculiar and unsatisfactory position. We are adding rapidly to our naval strength, and boilers of some kind must be put into our ships. What shall they be? Two alternatives are open. Either a limited number of ships shall be fitted with water-tube boilers, while Scotch boilers are put into the remainder, or else the recommendation of the Committee must be fully adopted. Until a thoroughly satisfactory type of water-tube boiler is obtained, the Committee recommend that, in large cruisers and battleships, cylindrical boilers of sufficient power to work the auxiliary machinery and to drive the ship at her ordinary cruising speed should be fitted; the steam pressure should be the same for the water-tube and cylindrical boilers, and may conveniently be 210 lb. per square inch, so as to give 200 lb. at the engines. By this means a considerable saving in coal will be effected, with a coresponding increase in the radius of action and general usefulness of the vessel. The water-tube boilers could be kept clean and perfectly efficient, as they need only be used for driving the ship at high speeds when economy of coal relatively is not so important. The cylindrical boilers should be fitted with retarders in the tubes, and with special means for circulating the water while raising steam.

We are not of those who hold that the Admiralty or Admiralty engineers are to be blamed for the existing position. So much may be urged in favor of water-tube boilers, that it would be fatuous to reject them utterly. But the paramount feature of the whole matter is that there is no sweeping condemnation of the Scotch boiler. There is no evidence that it is unsuitable for warships; the most that can be urged is that, while admitting that it is good, the water-tube system is better. We do not dispute this assertion, we do not confirm it; all that we can do is to echo the words of the Committee. It may be that the water-tube will better comply with a host of varied conditions than the cylindrical boiler; but it will require some four or five years' trial to carry this assertion to the point of proof.—*The Engineer*, July 11, 1902.

DOCKS.

THE GREAT FLOATING DOCKS OF BERMUDA AND ALGIERS, LA.—Particular interest attaches just now to the question of drydocks, on account of the fact that the Illinois, the latest of our battleships to be put in commission, is now in drydock abroad, for the repair of serious damage done to her hull by running aground while she was on the European station. It was this fine vessel that was chosen to represent the United States at the great naval review at Spithead, which was organized as part of the ceremonies attendant on the coronation of King Edward VII. After the postponement of the review, the Illinois had the misfortune to run aground on rocky bottom and tear open the forward part of her hull, thereby flooding one of the forward compartments and rendering extensive repairs in drydock necessary.

This sudden crippling of our finest battleship will naturally direct renewed attention to the two great floating drydocks which have recently been constructed and placed in service. One of these, constructed for Bermuda, was built by Messrs. C. S. Swan & Huster, of Wallsend-on-Tyne; another, which is now at Algiers, La., was built by the Maryland Steel Company at Sparrow's Point. Both of these were designed by Messrs. Clark and Standfield, London. Although the Bermuda dock is actually the largest, the Algiers dock is the more powerful. It may be interesting here to institute a comparison between these two and also the old floating dock, which was towed out to Bermuda in 1869, and which is to-day one of the largest floating docks in the world.

	New Bermuda Dock.	Algiers Dock.	Old Bermuda Dock.
Length of dock	545 feet	525	381
Length of end pontoon	120 feet		
Length of middle pontoon	300 feet		
Width between fenders	100 feet		84
Width of pontoon	96 feet		
Height of vertical walls	53 feet 3 in.		
Length of vertical walls	435 feet		
Thickness of wall	13 feet 1 in.		
Total width of structure	126 feet	100 feet	128 feet 9 in.
Lifting power up to deck level	15,500 tons	18,000 tons	8,000 tons
Extreme lifting power	17,500 tons	20,000 tons	10,000 tons
Weight of hull	6,500 tons	5,850 tons	

When it became evident that a new dock must be made at Bermuda the Admiralty were anxious to get an ordinary graving dock made. Borings were made, but everywhere the geological formation proved unsuitable for the purpose. The old dock was rendered obsolete, not from decay, but because ships have increased so greatly in weight and in dimensions.

The simplest definition of a graving dock (by which we mean the sunken or excavated type) is a hole dug out in the foreshore below high tide level, with its sea-end closed by a caisson or gate. The vessel is floated into the excavation, the ends closed by a gate, and the water then pumped out. Similarly a floating dock may be defined as a box built of wood or steel, which is allowed to fill with water so that it sinks. The vessel to be docked is drawn over it, the water in it pumped out, and by its buoyancy it lifts the vessel out of the water.

The modern floating dock is "self-docking." This means that it is capable of taking itself to pieces and lifting any one part out of the water when necessary for cleaning or repair. This is a very necessary condition in a hot climate, where floating structures are exceedingly liable to have their bottoms incrusted with marine organisms and slime.

The new Bermuda floating dock consists mainly of five chief parts, comprising three pontoons and two side walls. The three pontoons form the bottom of the dock and are placed between the side walls; they form the main lifting portion of the dock. The two side walls are chiefly designed to give stability and to afford control over the dock in sinking it to take the ship on board; they also do some of the lifting work. The center pontoon is 300 feet long and is rectangular in shape; the two end pontoons are each 120 feet long and have each 70 feet of the length rectangular in plan, the outer portions being beveled off in a way that will facilitate towing. The side walls are each 435 feet long and 53 feet 3 inches high. For the purpose of admitting light and air under the bottom of a vessel when docked there are two large openings in each of the side walls. The ends of the side walls are beveled off to carry out the lines of the end pontoons. The vertical side walls are firmly attached to the pontoon bottom, being fastened by double fish-plates and tapered pins, to take which there are steel lugs built into the structure, both of the walls and pontoons.

The new Bermuda dock is both longer and heavier than any floating dock that has ever before been built. It is 545 feet long, and its clear width between rubbing-fenders is 100 feet. As the side walls are a little over 13 feet across, the total width of the structure is somewhat above 126 feet. The lifting power up to the floating deck level is 15,500 tons; but by using the shallow pound this can be increased to 17,500 tons. The weight of the hull is 6500 tons. The sides or walls are high enough to enable a vessel of 32 feet draft to be berthed on the keel block, the latter being 3 feet 6 inches high.

The new dock is capable both of docking itself and also of docking a battleship or cruiser. Each of the side walls can be lifted separately out of the water, and each of the pontoons can be lifted separately, so that any portion of the dock can be examined, cleaned, repaired or painted as occasion requires.

For the docking of a vessel the dock is sunk to a certain depth by taking in water ballast; the ship is then floated over, and, the water being pumped out, the vessel is lifted out of the water, thus allowing of

repairs being made in her under portions. The three pontoons are divided into 40 pumping divisions, and of these 32 are water-tight. The side walls have also 8 water-tight compartments in each. All these divisions are provided with a separate pipe each, with a valve. All the pipes on each side lead directly into the main drain of their respective side. There are four 18-inch centrifugal pumps in each wall, and any one pump can empty all the compartments in its half of the dock. If the whole of the pumping machinery on one side were to break down, the other half could still empty the dock, though, of course, at a slow pace. The pumps are driven each by a separate compound condensing engine directly attached.

Although the new Bermuda dock exceeds the Algiers structure in length by 20 feet and in weight by 650 tons, the latter has greater lifting capacity. It recently lifted the United States battleship Illinois, a vessel of 11,565 tons displacement. Up to positive level it will raise 18,000 tons, and if the "pound" be utilized the capacity could be increased to 20,000 tons.

The battleship Sans Pareil was selected to test the new dock. This battleship is a sister ship to the ill-fated Victoria, rammed by the Camperdown in the Mediterrean in June, 1893. She is 340 feet long and 70 feet wide. Her armor is 18 inches, tapering to 16, and she carries ten 16¼ 110-ton guns in one heavily armored turret well forward. These guns are the largest carried in any fleet. The Sans Pareil entered the dock about 12 o'clock, and she was then drawing about 27 feet 4 inches.

At a little after 2 o'clock the pumps were started and they were kept at work until the battleship was lifted out of the water and the pontoon deck was high and dry. The lifting of the Sans Pareil took about an hour, and the port guardship at Sheerness was then towed back to her moorings. During the docking care had to be taken that both sides of the dock rose equally, and on this occasion all fortunately went well.

The new Algiers floating dock recently successfully lifted the United States battleship Illinois, of 11,565 tons displacement, and a word may be said here as to the different methods employed for docking vessels in the British and American navies. The American plan is to attach to the bottom of the ship exterior longitudinals or stout side keels. Rows of blocks are placed for these in the docks, as well as the usual blocks for the central keel. The vessel then sits upright on level blocks and requires no shoring except for centering. The British method is to poise the ship on her keel and prop it up by a large number of raking struts and bilge shores. The former plan certainly saves time, and it is stated that the docking keels have no appreciable effect on the speed of the ship with which they are built. Those who are against the American plan argue that as a ship passes very little of her time in drydock it is better that such a weight should be at rest in one drydock than that hundreds of ships should have to transport the burden all over the world.

In certain quarters there has been, and is perhaps still, a prejudice against floating docks, but the successful docking of the Sans Pareil and the Illinois in the two new great docks should do much to convince critics that the floating dock is capable of performing any work that may be required of it. It would perhaps surprise many people to hear what an amount of sea these docks can stand. Floating docks have been moored in the open Pacific for a number of years, and we learn

that they have succeeded in dealing with vessels in quite a respectable swell. The two floating docks of this type have often been at work in bad weather when the graving docks in the vicinity have been unworkable.—ROBERT C. FYFE, London, Eng., in *Scientific American.*

ELECTRICITY.

ELECTRICITY IN THE NAVY.*

By WALTER M. MCFARLAND.

In discussing the applications of electricity in the navy, my remarks as to specific installations will be mainly with respect to power plants and motor installations on shore, both on account of the fact that the company with which I am identified has done virtually no ship work for the navy, and because my own duties while a naval officer had little connection with such work. My experience, however, has suggested some points in connection with the use of electric apparatus on war vessels which may be of interest and possibly may afford some information.

The use of electricity in the navy was at first for purposes connected with the torpedo service, and when electric lighting became practicable its exploitation for the navy was taken up by the officers who had been devoting their attention largely to torpedoes. After some preliminary installations had been made, a board of officers investigated the conditions for lighting on war vessels with considerable care and formulated certain rules with respect to voltage, temperature limits, etc. Until very recently the general rules formulated by that board have governed all installations on our naval vessels.

The standard voltage was put at 80, and in discussing the reason for the choice of this figure some time ago with the Naval Inspector of Electric Lighting, he informed me that it was virtually determined by the requirements of the searchlights. It had been found that it was impracticable to use two of them in series, and as they only required 50 volts each, it was felt that a higher voltage than 80 for the standard would cause too much loss due to resistance of the searchlight circuit.

The limits for temperature rise were considerably lower than have been found entirely practicable for standard practice on shore, and the explanation for using these lower limits was that the temperature conditions on board ship were much more arduous than on shore owing to the location of the dynamo room below the protective deck, which involved a very much higher initial temperature than that usually found on shore. Not to go into other details, it may be said at once that these requirements of low voltage and very low temperature limit, made the generators for naval use entirely special, with the result that unless some one concern could secure practically all the work and thus build enough of these machines to cover the development changes, naval work from a commercial standpoint would not be at all desirable. This explains why the company with which I am connected has made no effort to secure any ship work in the navy. Another large company, however, went systematically into the business of preparing to meet the

*Read at the 166th meeting of the American Institute of Electrical Engineers at New York, May 28, 1902.

demands, and as a result has installed the great bulk of electric machinery on our naval vessels. In view of the foregoing facts, it was somewhat surprising to read in the annual report of the officer having charge of electric matters in the navy a few years ago, the statement that he was in the hands of a monopoly, and that he advocated building electric machinery in the navy yards. As I told him when I once spoke to him about the matter, if the navy were satisfied to accept what everybody else found efficient and thoroughly satisfactory, there would be no trouble with respect to competition. As a matter of fact, government inspection is rigid and exacting to a degree which is not dreamed of in ordinary transactions, with the result that a machine, admirable in all respects but one, might be rejected on account of a slight excess in temperature rise in some one part. If the machines were standard in every way this would not make such a great difference, as such a trifling variation would not carry any weight with the ordinary customer; but when the machines are of such an odd voltage there is, of course, no way of selling them as they stand to any other customer, and consequently if rejected by the government they would have only a scrap value.

In the report of the Bureau of Equipment of October, 1900, it was recommended that the navy standard of voltage be raised from 80 to 110 volts, and that special dynamos of 55 volts be employed for running searchlights. The recommendation states that one of the advantages will be to increase the field of competition, and that facilities for obtaining supplies will be improved on account of the commercial voltage being 110. This, of course, is true, but it is only carrying the change half way. What should be done is to adopt the commercial standards throughout, which would enable the apparatus installed to be of the type that is steadily manufactured in large quantities at very moderate cost and for which repair parts could readily be obtained from the storehouses of the different companies located at the principal ports.

If the claims that the dynamo-rooms of war vessels are so abnormally hot as to represent conditions very much harder than any to which dynamos on shore are subjected were accurate, there would, of course, be ample justification for the low limits of temperature rise, but, as a matter of fact, there are places on shore where the temperature conditions of the dynamo-room are worse than on naval vessels. I have in mind a case where there was some delay in testing an installation in which I was interested, and the reason given for the delay was that the engineers who were to make the test were unwilling to stay in the dynamo-room long enough during the summer season to make the test, and insisted on waiting until cold weather had set in. Any one familiar with conditions obtaining on shore can undoubtedly cite cases in his own experience where the temperature of the dynamo-room would run up to 140 or 150 degrees at times, which is a higher temperature than I have ever heard cited for the dynamo-rooms of naval vessels. In all these cases, standard machines with the usual limits for temperature rise have given satisfaction.

There is another very decided objection to the use of non-standard apparatus due to the low limits specified for temperature rise, namely, that the machinery must inevitably be considerably heavier. This is a point which appeals to me very strongly, on account of the fact that the main machinery in naval vessels is rigidly limited in weight, and

the unfortunate contractor is compelled to pay a penalty for all overweight. It always seemed to me absurd that when such vitally important things as the propelling engines for driving the ship had a weight limit put upon them, the electric equipment was either not limited or, on account of peculiarities in the requirements, was allowed to be much heavier than it might have been if made according to the best standard practice.

As you are all aware, the use of electricity on board ship for power has been of comparatively recent introduction, the first important case being the turret-turning machinery of the Brooklyn, which was installed about 1896. This was followed by the more elaborate installations on the Kearsarge and Kentucky, where all the turrets were turned electrically and motors were also used for ammunition hoists, boat winches, ventilating blowers, and some other purposes. While I have not personally served on board of ships with electric power apparatus I understand that it has generally given satisfaction.

Among the chief reasons which appeal to the layman as well as the engineer for the use of motors rather than steam engines is the absence of long lines of piping, which unduly heat the spaces through which they pass in hot weather, and the avoidance of the chance of leakage. It would seem that on this line of thought, the two places of all others where motors should have been installed are for the capstan and steering engines, but while there have been a few officers in the navy to advocate this, the consensus of opinion has been against it. I do not know the exact reasons assigned further than a sort of dread that the motors would be unreliable, but I presume that where the objection was made by officers acquainted with electric apparatus, it was due to the fear that in both of these places there would be times when the motor would be brought up standing under load, and under such circumstances direct current motors, unless protected by external safety devices, would be burnt out, and these external devices would add to the complication and chance of derangement. It is undoubtedly a fact that both the capstan and the rudder are at times subjected to conditions where the motive power will be brought up standing, so that unless safe-guards were provided there certainly would be danger of serious damage.

This last point leads me to bring up the point of the adaptability of alternating current apparatus to use on shipboard. Indeed, I may say that although I had thought about it a great deal myself, the question was asked me by a naval officer during a recent visit to one of our large battleships, why alternating current was not used. Of course the immediate answer is that the naval authorities in charge of electric apparatus still limit all electric machinery on shipboard to that operated by direct current. It seems to me, however, that the conditions on shipboard are such as to make the points which constitute the advantages of alternating over direct current apparatus of unusual weight. From the very nature of things the electric apparatus is to a considerable extent handled by men without a great deal of skill, a point to which attention has been called by the chief of the Bureau of Equipment in some of his annual reports, where he laments that the supply of trained men is not sufficient. Further than this, the induction motor with its extreme simplicity and ability to withstand abuse and neglect seems much better adapted to the general run of conditions on board ship

than the more delicate direct current motor. With its ability to stand a tremendous overload and even temporary stoppage, it would answer for driving capstans and steering gear, from which the direct current motors have thus far been barred out. It would also seem admirably adapted for such work as driving the forced draft blowers for the fire-rooms, which are usually located in almost inaccessible places and where the steam engines now used to drive them, can rarely receive adequate attention when the blowers are driven at full power. Only recently I heard one of the ablest engineers in the navy comment on this very point, of the adaptability of the induction motor for this particular service. The only objection to the use of alternating current that occurs to me is the requirements in searchlights, but, as I remarked above, it is already proposed to install a special generating set, even where direct current is used, to supply the searchlights, and it will be perfectly practicable to put in a motor generating set giving direct current for searchlights, while alternating current would be used elsewhere.

While speaking about this use of motors in the department of the propelling machinery of the vessel, it seems pertinent to call attention to the fact that claims have been made for the adaptability of motors to drive the motive machinery which seem ill-advised. These claims are based largely on the admitted high steam consumption of many of the steam auxiliaries against which a much lower steam consumption could be figured where these same auxiliaries were driven by motors. The fact must not be overlooked that on war vessels, as at present designed, the dynamo-room is at a considerable distance from the boilers, involving long lines of steam and exhaust piping, while the steam auxiliaries in engine and fire-rooms are so situated that the steam and exhaust connections to them are very short. Further than this, while the steam consumption of these auxiliaries, considered alone, is undoubtedly very high, the fact was overlooked by those advocating the use of motors, and who were not familiar with the details of propelling machinery, that provision has for some years been made for turning the exhaust from these auxiliaries either into the receivers of the main engine, or into the feed water heater. In either case the steam expenditure was enormously reduced and the heat in the steam utilized in the fullest extent possible, under which circumstances their steam consumption per horsepower would be lower than that with the motor drive. It is sufficient to note that where the steam is turned into the receiver, the cylinders of the auxiliary become in effect an extension of one of the cylinders of the main engine and, consequently, the steam consumption becomes the same as that of the main engine, which even at reduced power is considerably below that of the small engines driving the dynamos.

There are enough places on board ship where motors can be used with great advantage, convenience and economy to make it unnecessary to urge their installation in places where they could not hope to give the satisfaction that is given by the steam auxiliaries, with respect to speed regulation, economy and weight.

My attention was recently called by a prominent officer of the navy department to a proposition made for sub-dividing the dynamo-room and having two, located in different parts of the ship, with the object of preventing the complete disablement of such vitally important things as the turrets and ammunition hoists in the event of a shell getting into the one dynamo-room as now arranged. I was very much surprised to

learn that objection had been made to this on the score of complication, and I cited the case of the Explotadora system in Mexico, where there are seven a. c. generating stations scattered along the mountain side at distances of from ten to twenty miles from the receiving station, where the current from the different stations is brought together on the same bus-bars and transmitted to the city of Mexico. It seems to me that this proposition is an eminently sound one, and while there would of course be a slight increase of complication, it would be as nothing compared with the increased safety against total disablement.

Installations on Shore.—Naval requirements for electric machinery on shore are practically for standard apparatus, so that here the criticisms which I have made do not apply. Each bureau decides on the apparatus which it deems best for its own purposes, and all who make apparatus of the class wanted have an opportunity to bid. This brings up the natural inquiry from those not familiar with naval matters as to why there should not be a central plant for each navy yard supplying all the current needed for use in the yard, whether for lighting or power. The reason why this has not obtained is, primarily, that all of our large navy yards have been established for some time, and that they were at first entirely steam-driven plants. As the yards are of large area, with the different shops scattered, it was, of course, the best practice at the time they were laid out to have individual power plants for each set of shops. Under the existing system of appropriations some bureaus were able to install an electric drive earlier than others, and in this way we have the present condition, where in a single navy yard there may be several power plants, each for its own particular set of shops. I think there is little doubt that in any new yards that are established the tools will be entirely motor-driven and the current will be derived from one or more power plants. I say one or more, because it would depend on the location of the yard. Where a yard is isolated, as in the case at Mare Island near San Francisco, or the proposed station in the Philippines, it would seem unsafe to put the whole power plant in one locality, for the reason that any damage such as that caused by a fire, earthquake, or other disaster, would lay up the whole yard. Where a navy yard is near a large city or other establishment having a large power plant, arrangements could probably be made, in case of damage to the yard's power plant, to rent current for a time.

Most of the apparatus installed in the navy yards is of the direct current type, probably because the earlier installations were made before the induction motor had become so prominent as it has in recent years, and consequently as installations were increased the direct current was necessarily adhered to. In some recent plants, however, while direct current is used, the installation has been on the three-wire system from a single generator on the Dobrowolski system. This has enabled larger and fewer units to be used, with resulting satisfaction.

In two very interesting plants alternating current has been used, with induction motors of course, the first at the ordnance proving grounds and powder factory, at Indian Head, Md., and the other at the steam engineering plant at the Brooklyn Navy Yard.

At Indian Head the induction motors commended themselves on account of their simplicity and absolute immunity from sparking, but as it was desired to have a short line of railway with an electric locomotive for hauling guns from the dock to the proving range, and for other

purposes, some direct current was also necessary and the generators installed are of the a. c., d. c. type. The railway is driven by what is known as the "button system," or electromagnetic traction system. It was undesirable to have overhead wires, and an underground trolley would also have been objectionable, while the button system answers the requirements of the case admirably. This plant has been installed about three years and has given great satisfaction.

The plant at the Brooklyn Navy Yard has been only recently put in operation, although the contract for it was made in 1899, the delay being due to the fact that the power house was not completed until last fall. In this case the Bureau of Steam Engineering detailed an officer who visited important manufacturing establishments all over the country to find the general opinion as to the best type of apparatus to install. He also visited various electrical manufacturing concerns to discuss with their engineers the merits of the different systems. As a result of his report, it was decided to use alternating current generators with induction motors for the tools, and the plant is an excellent illustration of the most advanced practice in the powering of a modern engine-building plant. Just about the time when this contract was placed, the large ship and engine-building establishment at Camden, N. J., known as the New York Shipbuilding Company, was also considering the question of electric driving, and after going into the matter very carefully under the guidance of a prominent electrical engineer, also decided for alternating current with induction motors. In this plant there is an unusually large number of cranes, and as the crane builders generally charge a considerably higher price for alternating current cranes, it was decided to drive them by direct current. As a result, the two 500 k. w. generators are of the a. c., d. c. type, like the much smaller ones at Indian Head.

A comparatively new field for the application of electricity in the navy yard is in the drydock machinery, and in all the contracts made since the early part of 1899, it has been arranged that the pumps are to be driven by motors and that the capstans and winches around the docks are also to be electrically driven. Power drive for the latter would be practically impossible except by the use of electricity. Thus far all of these installations have been by direct current, but I believe there is little doubt that as the naval authorities who have charge of these matters become more familiar with the advantages of alternating current apparatus, this form will be used, because it seems much better adapted to the circumstances of the case than direct current.

Naval work on shore where electricity can be applied is largely in the nature of manufacturing and repair establishments, and consequently we should expect that the equipment which commercial manufacturers find to give them the best results would be adopted for the navy. This is, indeed, the case, and just as no large manufacturing establishment under private auspices now dreams of using anything but the electric drive for its tools, so the same thing is true of naval establishments.

With respect to the application of electricity on shipboard, the circumstances are such as to give a very promising field for the application of electricity, and my own opinion is that if alternating current were adopted there would be a much greater number of motors installed than at present.—*The Nautical Gazette*, June 5, 1902.

ELECTRICITY IN ITS APPLICATION TO SUBMARINE MINES.*

By Capt. John Stephen Sewell, U. S. A.

A system of submarine mines usually involves stationary torpedoes planted under water, anchors for holding them in position, cables for connecting them electrically with the shore, and operating apparatus in a sheltered position on shore. The torpedo itself is usually a metal case, containing a charge of suitable explosive, with necessary detonators, etc. It may, and in shallow water, usually does, rest on the bottom, the metal envelope being in this case sufficiently heavy to act as an anchor. In water more than thirty-five or forty feet deep the torpedo is usually buoyant, and is held in place by a separate anchor and mooring rope. Torpedoes may be purely mechanical in their action; in this case there are usually a number of movable pistons projecting through stuffing boxes at various points, and so arranged that if driven in by the impact of a vessel they will explode a detonator, which in turn will explode the torpedo. It will be readily granted that such torpedoes are dangerous to handle, and are not likely to remain long in an efficient condition in sea water. Again, in some rare instances, use may be made of what might be called self-acting electrical torpedoes, in which a battery and circuit closer, in series with an electrical detonator, are inclosed in the metal case along with the charge of explosive. The circuit closer is supposed to act under the impact of a vessel and the battery does the rest. Some form of dry cell is manifestly the only proper battery for such uses.

In planting self-acting mines it is necessary to have a safety device which will maintain an open circuit, in spite of the circuit closer, until the operations of handling and planting are completed and those engaged in the work have had time to put a safe distance between themselves and the mine. After this, such a torpedo is dangerous alike to friend and foe, and its removal is an exceedingly delicate operation. For this reason, and also because a thoroughly satisfactory safety device is very hard to find, self-acting mines have a very restricted sphere of usefulness.

By far the greater part of all submarine mines are electrically operated from the shore. This follows directly from a consideration of the conditions to be met in devising a system of mines. It is very desirable for a mine to explode automatically when struck by a hostile vessel, but it is equally desirable for it not to explode if it is struck by a friendly vessel; the defense should also be able to explode the mines at will from the shore, in case a hostile vessel comes near but seems likely to miss them. All these things are rendered possible by mines electrically operated from the shore.

It is necessary, of course, to proceed with accuracy and precision in order to attain successful results with such a system. Mines are, primarily, obstructions and not weapons; their principal function is to prevent the enemy from running by the batteries, which experience has demonstrated that he can do if he has a clear channel. They must be located where, if he tries to remove them, he will be detained under the close fire of the shore guns; otherwise he would remove them and then

* Paper read at the annual meeting of the American Institute of Electrical Engineers, in New York, May 20, 1902.

run by. They must be sufficiently numerous to prevent his opening a channel through them by the sacrifice of any reasonable number of vessels sent in to receive an explosion and then turn to one side and sink out of the channel. They must be accurately located and planted in regular order, so that there will be no mistake about exploding the proper mine in judgment firing, and that in case of automatic firing the exploded torpedo may be replaced with the least delay.

It is customary to plant mines in smaller and larger groups; usually more than one torpedo will be attached to a single cable core, and the various cores, as they approach the shore, will be gathered into a multiple cable of several cores. Thus, starting with a cable of ten cores, it should be laid by the most direct line from the operating casemate to a convenient point in the rear of the line of mines it is to serve; there, by means of a large junction box, it would be connected with ten single core cables, each leading to one of a line of smaller junction boxes; at the small junction boxes each single conductor branches into perhaps three other single conductor cables, each of the latter going to a torpedo. By this arrangement when firing is by judgment, which involves some uncertainty as to the actual distance of the hostile vessel from the mines, the defense explodes three charges at once, thus increasing the probability of an effective blow; if, on the other hand, the hostile vessel strikes a torpedo, only that one will explode, and being in contact with its target it ought to be sufficient.

Coming now to the electrical arrangements, if firing were by judgment alone, nothing would be needed but a circuit from the firing battery through the detonators in the torpedo to earth with a firing key in the casemate. Even very defective insulation would not interfere with the working of the system, if the firing battery is enduring and sufficiently powerful. It would interfere with the daily tests, however, because of the variations in resistance which would occur even if no leaks or other defects develop in the torpedo itself. If firing is by contact alone the necessary arrangements are a little more complex.

In order to admit of daily electrical tests—which must include the circuit through the detonators to be of any value—there must be a continuous circuit through the torpedo; it must be of high resistance, so that even if the firing battery is on it cannot fire the mine. There must be a circuit closer in series with the detonators and in parallel with the high resistance. When the mine is struck the circuit closer acts and opens up a circuit of low resistance through the detonators. It is assumed that the detonators are of the type having a continuous bridge of fine wire, surrounded by some fulminating substance, and that it is designed for a relatively large current under moderate emf. This is the most certain and reliable form and is always easy to obtain. If the firing battery is on, the torpedo should explode when the circuit closer acts.

It is desirable, however, to know whether a torpedo is struck, or whether its circuit closer acts from any other causes, even if the mine is not to be fired. Moreover, it is objectionable to keep the cables under such high voltage as is necessary in a firing battery. It therefore becomes desirable to have another battery of very constant emf. always on the circuit. Its emf. and all the resistances in circuit should be so proportioned that normally a tiny current is always flowing; but when a circuit closer acts this current should increase to such a point that it

will drop a signal, showing to which triple group the torpedo belongs, and also close the circuit of the firing battery through the corresponding cable core. In case the torpedo is fired, the explosion may cause the circuit closers of neighboring mines to act and thus the whole system might go up, seriatim. To prevent this some device is needed which will allow the firing current to flow long enough to explode certainly the mine that is struck, but which will break it immediately thereafter and keep it broken long enough for neighboring mines to right themselves. It should be remarked here that if ground mines are used for automatic firing the circuit closer must be carried in a buoy, similar in form to a buoyant torpedo anchored to the ground mine, and having an electrical connection with it; so that, with ground mines, the requirements are the same as with buoyant mines.

It will readily be seen that to accomplish all the above objects a more or less complicated set of apparatus is required. It is a good plan so to arrange the signal drops that when they fall they will close a bell circuit, thus causing a bell to ring continuously until the signal is raised; it is also well for the device which cuts off the firing battery after an explosion to ring a bell as long as the firing circuit is open; this gives reasonable assurance that a mine has exploded, even if in the noise of battle the explosion itself is not heard; pilot lights would do as well as a bell. It is also well to have a very feeble battery for testing purposes only; thus it will already be seen that there may be as many as five separate circuits to provide for in the operating casemate. In addition there may be one more; if a torpedo is struck and fired the end of the cable leading to it will form an earth which, if cut out, might be sufficiently good to keep throwing the firing battery on; it would so alter the resistances as to interfere seriously with the proper working of the system at any rate. At the triple junction box a fuse could be inserted to carry the firing current, but susceptible of being blown by a more powerful one to be applied as soon as the other mines of the group have righted themselves. If now we assume that a small engine and dynamo are used, in connection with storage batteries, to supply current to various circuits, it will readily be seen that the switchboard problem in the casemate is not simple.

If, in addition to automatic firing, it is desired to use judgment firing, we must be able to switch out the high resistance in the mine, or else have this resistance in the form of the primary of an induction coil, with additional detonators in its secondary circuit; in this case an intermittent or alternating current of high potential and small volume, flowing in the primary, would induce a firing current in the secondary. A whole triple group would then be fired, and the corresponding core of the multiple cable would be detached from the operating apparatus altogether, until such time as the mines could be replaced.

In purely automatic firing the high resistance might be omitted altogether, but then a break in the cable core would give the same indication as a mine in normal condition, and the torpedo itself might be filled with water and sunk to the bottom without the fact being discovered.

The daily tests consist in measuring the resistances of the various circuits and testing all movable parts in the operating casemate. Damage to the system always affects these tests and the expert electrician in charge must learn to infer, from his tests, what the probable nature of the damage is.

It will readily be seen that except for purely judgment firing the insulation resistance of cables and joints must be very high and must remain so. Details of apparatus actually in use have been omitted in this paper, because they are classed as confidential, but enough has been said to show to an electrical engineer that submarine mining presents some problems that demand serious attention. Not the least of these is the problem of junction boxes which will allow of rapid jointing work, of a quality sufficiently good to withstand submersion in sea water for months at a time. Another serious problem is the cable itself. It takes time to make it. If it is kept in store, either wet or dry, the insulation becomes brittle, and when the cable is unwound from the reels in laying the insulation cracks. Hitherto the cable used for this purpose has been insulated, taped and armored. While the work has been of a high grade, it seems to the writer that we will have to come to the use of cable having a lead covering outside or the insulation and steel wire armor outside of the lead. Then, as long as the lead is intact, cracks in the insulation will be of no consequence. But this form of cable will be heavier, harder to handle, more difficult to splice, and considerably more expensive than the armored cables without the lead.

Even after the details of a system of mines are satisfactorily worked out, the planting is a very serious matter, and always will be, unless we discover some way of controlling and firing the mines by induction, without electrical connections from the shore, thus eliminating the cable. Possibly the development of wireless telegraphy may ultimately make this possible, but it is not yet in sight.

THE REASONS FOR THE CHANGE OF THE NAVY STANDARD VOLTAGE FROM 80 TO 125.*

By Lieut. W. V. N. Powelson, U. S. N.

Before proceeding to a discussion of the considerations which led to the recent adoption by the Navy Department of 125 volts as the standard for all new installations on board ship, it may not be out of place to review briefly the history of the voltages used by the navy.

In the first installations, and previous to 1888, two voltages were used on board the same vessel. Generators of 110 volts were used for supplying power for the incandescent lights and generators of 50 volts were employed for the operation of the searchlights.

In May, 1888, a board was appointed to decide upon a single standard voltage at which power might be supplied to operate both the incandescent lamps and the searchlights. This board as a compromise selected a voltage of 80, the mean of the voltages already in use.

One very important consideration at that time which prevented the adoption of the commercial voltage of 110 as the standard was no doubt the apparently enormous waste of energy in the rheostat that must be employed to cut down the voltages 110 to about 45, the arc voltage of the searchlights at that time.

It must be remembered that the searchlights in the early installations required a very large percentage of the total electrical energy developed on board ship, and therefore their position was a most important one in any discussion affecting the voltage of the generators. Now the posi-

*Paper read at the Annual meeting of the American Institute of Electrical Engineers, at New York, May 28.

tion occupied by the searchlights in relation to the total power developed is minor.

Since 1888 the standard voltage of the generators on board ship has been 80, and the difference of potential between all distributing lines has been 80 volts except in the Kearsarge, and in the Kentucky, battleships of about 12,000 tons, commissioned in 1899. In these ships a new and radical departure was made in the system of distributing power. The generators were wound for 80 volts, but the wiring arrangements were such as to permit of the transmission of energy on either the two-wire 80-volt system or the three-wire system with 160 volts difference in potential between the outside wires. Although a discussion of the advantages and disadvantages of this system compared with an 80-volt two-wire system would no doubt prove of interest, it is beyond the scope of the present paper.

The attention of the Navy Department was, in 1901, strongly drawn to the necessity of changing the standard voltage 80 by the difficulty which it experienced in the purchase of its electrical material owing to its special character, and one year ago a board was appointed to consider again the question of a standard voltage for the navy. Since any increase of voltage would permit of a reduction in the size of the transmission lines it was desired to raise the voltage to that limit where the advantages to be derived from this circumstance began to be outweighed by certain disadvantages.

These disadvantages might result from the difficulty of making lamps for the particular voltage, from the fact that the voltage was not commercial or from the danger from shocks, bad arcing, grounds and electrolytic action due to moisture getting into the water-tight boxes.

The voltages from which the choice might be made were 110, 125, 220, 250, 500 and 550. In view of the recommendation of the Committee on Standards of this Institute the choice was narrowed down to 125, 250 and 550 volts. One hundred and ten volts was passed because 125 volts possessed all the advantages of a 110-volt system with certain additional advantages, and no additional disadvantages except in the matter of operation of the searchlights. At that time the plant of the Kearsarge had been running for some months with a difference of potential of 160 volts between wires and no bad effects had been noted from shocks, arcing grounds or electrolytic action, and no trouble on this score was therefore to be expected from the use of 125 volts.

Two hundred and fifty and 550 volts were discarded for the following reasons:

(*a*) The difficulty that it was expected would accompany the purchase of satisfactory incandescent lamps.

(*b*) The additional waste of power in operating searchlights.

(*c*) The probable necessity of re-designing the standard wiring appliances.

(*d*) The very large increase over any voltage formerly used on board ship.

In considering the question of a change of voltage inquiry was made to determine:

(*a*) What advantages would be secured by the adoption of a voltage from the mere fact that it was commercial irrespective of any consideration of its absolute value.

(*b*) What effect would a change to the most suitable commercial vol-

tage have upon the cost and weight of electrical apparatus used on board ship.

(*c*) What effect would a raise in voltage have upon the efficiency of operation of electrical apparatus on board ship.

Advantages of Using a Commercial Voltage.

An advantage which is always sure to follow the adoption of a commercial article is a large reduction in the time of delivery and in any naval organization this may become of supreme importance. It does not always follow that a reduction in price will result. This will depend upon how special the former apparatus was and in how large quantities it was purchased. Take for instance the incandescent lamps. The navy has been buying a special 16 c. p. lamp of 80 volts, 3.8 watts efficiency and equipped with a bulb of special shape. Notwithstanding the special character of this lamp the navy has not paid a higher price than a commercial lamp would cost for two reasons:

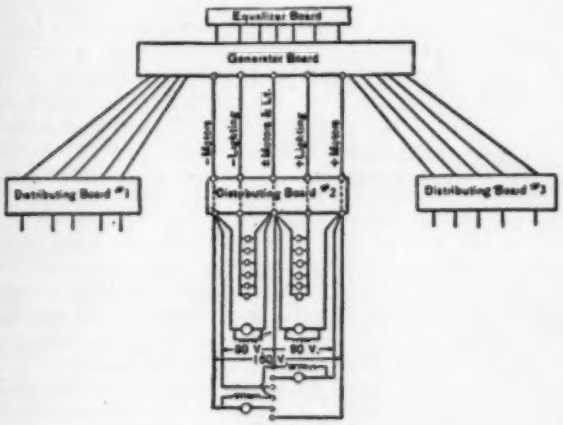


Fig. 1.

(*a*) Because the limits of variation in volts and watts per candle at the rated candle power have been so large, viz.: 8 to 82 volts and 3.5 to 4.0 watts, and

(*b*) Because lamps have been ordered in fairly large quantities.

It must be apparent that if a special voltage is used, a purchaser must pay more for his lamps than the price of a commercial article, or he must allow such variations in the volts and watts per candle as will permit a manufacturer to make up a lot of lamps practically all of which will fall between the limits allowed. If the limits are so narrow that on an average only half of the finished lamps fall between the allowed limits the manufacturer must charge double if the voltage is so special that the other lamps cannot be sold.

If a purchaser who has been buying lamps of special voltage orders lamps, however, of any voltage between 100 and 125, he can reduce the limits of variation in volts and watts per candle without any increase in price because there is a demand for lamps of all voltages from 100 to 125, and the lamps which fall outside his limits can readily be sold to

some one else and the manufacturer suffers no loss. In the purchase of lamps, therefore the advantages to be derived from the adoption of a commercial voltage are:

(*a*) quick deliveries,

(*b*) closer selection.

These advantages will, however, not be secured if any of the required features of the lamps are special. A special shape of bulb or a special wattage would at once defeat both of the advantages which might be derived.

In the matter of generators and motors the possible advantages to be derived from the adoption of a commercial voltage are:

(*a*) quick deliveries,

(*b*) decreased cost.

Whether or not these advantages will be secured, depends almost entirely upon whether the navy adopts the heating limits allowed in commercial work, *i. e.*, the limits recommended by the Committee on Standards of this Institute.

The navy heating limits are at the present time considerably below the commercial limits and a commercial generator or motor must be redesigned in its windings and re-rated at a lower rating in order to meet the navy specifications. Unless the commercial heating limits are adopted, our generators and motors will still be special and no advantage either in price or time of delivery is likely to follow a change to a commercial voltage.

In the matter of insulated wire, however, a change to a commercial voltage will secure the only advantage possible—that of decreased cost—and this advantage will be fully obtained without regard to the special character of the wire used, for the reason that any increase in voltage will permit the size of wire to be reduced and the navy standard thickness of insulation is strong enough to withstand easily any commercial low tension voltage.

In order to determine how much of a saving in cost and weight of wire and conduit would result in a battleship of the size of the Kearsarge if the voltage were raised from 80 to 125 when using a plain two-wire system, certain calculations were made as shown in tables 1 to 9.

So much has been claimed for the three-wire system as installed on the Kearsarge in the matter of saving in cost and weight of wire that it was decided to include in the tables above mentioned, the cost and weight of the wiring as actually installed so that a comparison might also be made between this system and the two-wire 125-volt system.

Before proceeding to a discussion of the tables it would be well to consider briefly the system of transmission actually installed on the Kearsarge. This system is shown diagrammatically in Fig. 1.

From the dynamo-room, power is transmitted to distributing boards forward and aft. The transmission is divided into two sections—one for power and one for lighting. Energy is distributed from the dynamo-room to the larger distribution boards of the three-wire system, employing five wires, the neutral being common to both power and lighting systems. From the distribution boards all the lighting is on the two-wire 80-volt system, while the power distribution is, with the exception of certain small motor circuits, all on the three-wire system. All the switchboards are, however, so arranged that the outside wires of the three-wire system may be placed in parallel so that any part of the

system may be worked with only one dynamo in operation at a pressure of 80 volts. In order that the system might be thus operated it was necessary to make the neutral wire of the power system the same size as the outside wires, this for the reason that the neutral must when thus employed take the sum of the currents in the outside wires. When working under 80 volts pressure, the current taken by the motors is approximately one-half the full load current, so that under these working conditions the neutral is taking a current equal to the full load current of an outside wire, when working the motors at 160 volts, and the neutral must therefore have the same section as the outside wires.

Weights.

Electric Machinery.—The weight of a dynamo or motor of a given output is practically independent of the voltage for which it is wound. The only dimensions of such machines that would vary appreciably for a given output with a moderate change of voltage would be the commutator dimensions. The surface of a commutator would vary inversely as the voltage, and its weight in a somewhat smaller proportion. It is estimated that a saving of not more than 1½ per cent in the total weight of a generating set could be effected by increasing its voltage from 80 to 125; and of not more than 2 per cent in the weight of an enclosed motor by a similar increase in voltage. This saving would result only on the assumption that each machine was accurately designed for its rated voltage. In practice it is doubtful whether there would be any saving at all, for it is the custom to work up standard commercial forms into something that will be just under the weight limit allowed by specifications.

Transmission Lines.—Except in a very few cases the size of all transmission lines on board ship is determined on the basis of a certain maximum allowable drop in voltage between the switchboard and the last lamp or motor, as the case may be. In other words, the lines are calculated for a given allowable percentage of loss of energy under full load. If, therefore, two transmitting systems of different potential are to be directly comparable, as regards the size of conductors, each must give the same efficiency of transmission. The sizes of the conductors in the two systems would vary in section inversely as the square of the voltage of the systems. In a 125-volt system, therefore, conductors could be employed having but 41 per cent of the copper section of conductors in an 80-volt system. The total weight of the corresponding insulated wires in the two systems would not, however, have the fixed ratio at 41 per cent, because the weight of the insulation is not a fixed percentage of the total weight of the wire for all sizes. The thickness of the navy standard insulation is practically independent of the size of wire, and hence in the smaller wires it is a larger proportion of the total weight of wire than in the larger sizes. This is shown in Table 1, column 5. There is a certain saving in weight due to an increase in voltage on all wires except No. 14 B. & S. of 4000 cm., and the double conductor of seven strands of No. 22 B. & S., used so largely in portables. It was not considered desirable to reduce the section of these wires, for the reason that a certain amount of mechanical strength is necessary in a wire to prevent its breaking. No fixed figure can therefore be named which will correctly represent the ratio between the aggregate weights of all the transmission lines under two different

voltages. The ratio will depend very largely on the sizes of wire used. The proportional saving will be larger, the heavier the wires. In a small ship having only a lighting plant in which the No. 14 wire is used in a large proportion, the proportional saving would be smaller. The percentage of saving would therefore be different for every type of ship, and in general terms would be larger the larger the ship. In order to determine what this saving would be, it is necessary to take each size of transmission line and calculate the particular reduction in each case due to the increase of voltage. Tables 5, 6 and 7 show a detailed calculation for the Kearsarge and Kentucky class. From this it will be seen that in these ships the ratio of the total weight of transmisson lines under a 125-volt to those under an 80-volt system (two-wire in each case) is 51½ per cent.

Table 2, column 16, gives the individual ratios of weights under the 80 and 125-volt systems for several sizes of wire used as feeders in the Kearsarge and Kentucky. This shows that the ratio varies from 42.4 per cent to 64.5 per cent for wires of sizes between 1,300,000 and 23,000 cm. These wires are, however, only feeder sizes and do not include the smaller wires used as sub-mains or as branches to single outlets. An inspection of the first two lines of Table 5 will show that the double conductor and the 4107 cm. wire, form a large proportion in both cost and weight of the entire lighting system of the Kearsarge and Kentucky and on neither of these wires is there any saving due to increased voltage. The proportional saving in weight in lighting systems will, therefore, on account of this small wire, always be less than in power systems. This is shown in the summary of "cost and weights," from Tables 5, 6, and 7. This summary shows the ratio of weights under a 125-volt two-wire system and an 80-volt two-wire system to be .435 in the power system, and .65 in the lighting, with the ratio .515 for the combined systems including all dynamo leads.

Conduit.—In Table 4, column 31, are shown the individual ratios of the weights of enameled conduit under the 80 and 125-volt systems for wire sizes from 1,300,000 cm. to 23,000 cm. This shows the ratios to vary from 60 per cent to 100 per cent.

Tables 8 and 9 give a detailed calculation of the weight of enameled conduit for the Kearsarge and Kentucky under an 80-volt two-wire system both for the lighting system and for the power system. The results show that an increase from 80 to 125 volts results in a reduction of 13.5 per cent in the weight of the conduit for the lighting system, and 37 per cent in the power system. The total reduction in weight of conduit for both systems combined is 26 per cent. As remarked under the heading of "Transmission Lines," the large amount of 4000 cm. wire common to the lighting system under each voltage, materially reduces the saving in the lighting compared with that effected in the power system.

Tables 8 and 9 were calculated on the assumption that all of the wire in the ship was run in conduit. As a matter of fact a considerable proportion of the large wire on the Kearsarge and Kentucky is run open on porcelain insulators. This practice may or may not be adhered to in the future, and it may be either expanded or contracted so that in order to get a comparison for a fixed condition the tables were calculated upon the assumption that all wire was in conduit.

Wiring Appliances.—The weight and size of these appliances would not be affected by an increase of voltage from 80 to 125.

Switchboards.—The copper section of all bus-bars and switches in a 125-volt system could be reduced to at least 64 per cent of the section in the 80-volt system. If reduced to 64 per cent of the section used in the 80-volt system, the current density would remain the same in the switches and bus-bars under each system. The heating, however, would be less in the 125 than in the 80-volt system, because the radiating surface per watt lost in heat would be greater in the 125-volt system.

Costs.

Electric Machinery.—The only saving in cost in electric machinery due to an increase of voltage, would be that due to the decreased size of the commutator in the higher voltage system. Such saving in cost due to an increase from 80 to 125 volts would probably not exceed 3 per cent in case of a generating set, and 5 per cent in the case of an enclosed motor. Such saving would result only on the assumption that the generators and motors were accurately designed for each system of voltage. In actual practice there would be little saving in the cost of these machines, owing to the fact that it is a common practice to work up commercial standards into such shape as will come within the weight and heating limits prescribed by the specifications.

Transmission Lines.—The cost of these would vary in the same general proportion as the weight under different voltage systems, though not exactly in the same proportion. Table 2, column 17, illustrates this point.

As pointed out under the subject of "weights," the saving due to an increased voltage will be less in the lighting than in the power systems. The ratios of costs are given in the summaries from Tables 5, 6 and 7. These show the saving in cost to be about 25½ per cent in the lighting system, and 55.6 per cent in the power system, giving a total saving in cost of insulated wire of 44.6 per cent including dynamo leads.

Conduit.—In Table 4, column 30, Appendix V, are shown the individual ratios of costs of enameled conduit under the 80 and 125-volt systems for wire sizes from 1,300,000 to 23,000 cm. This shows that the ratios vary from 56.5 per cent to 100 per cent.

Tables 8 and 9 give a detailed calculation of the cost of enameled conduit for the Kearsarge and Kentucky under an 80-volt two-wire system and under a 125-volt two-wire system. The figures show that an increase from 80 to 125 volts results in a reduction of 11.6 per cent in the cost of the conduit for the lighting system, and 37.1 per cent in the power system. The total reduction in cost of the conduit for both systems combined is 24.8 per cent.

Wiring Appliances.—The cost of these appliances would not be affected by any change in voltage from 80 to 125.

Switchboards.—As pointed out under the subject of "weights," the saving in copper will amount to about 36 per cent. The saving in the total cost of the board cannot be calculated with accuracy for all conditions but is estimated at from 15 to 20 per cent.

Incandescent Lamps.

As pointed out above, a change from 80 to 125 volts will not affect the price of incandescent lamps, but will admit of reducing the limits of variation allowed in voltage and watts per candle.

Efficiency of Operation.—No change in efficiency of operation of gen-

erators or motors is to be expected from a change from 80 to 125 volts. The efficiency of incandescent lamps is a matter of specification, as lamps for any reasonable efficiency can be easily manufactured. It was not proposed to effect any increase in the efficiency of the transmission lines by the increase from 80 to 125 volts. For lines of equal section, the efficiency of transmission would be greater under the 125-volt system, but it was deemed best to sacrifice this advantage in favor of the reduced first cost which would be effected by so apportioning the sizes of the transmission lines that they would give equal efficiency of transmission under each system. In circuits, however, which use 4000 cm. wire under the 80-volt system, as pointed out above, there will be no saving in first cost due to the adoption of the 125-volt system, but there will be a saving in the efficiency of transmission. The losses in these circuits under the 125-volt system will be to the losses under the 80-volt system as 41 is to 100.

The searchlight is the only piece of apparatus on board ship whose efficiency of operation is seriously affected by an increase of voltage. A searchlight is merely an automatic self-regulating arc lamp mounted in front of a projector. The function of the self-regulating mechanism is to keep the voltage across the arc constant. The arc voltage therefore becomes one of the most essential features of a searchlight lamp. This arc voltage is not an inflexible quantity inherent in the character of an electric arc, but it will permit of a comparatively wide variation under certain conditions. The condition having the greatest effect on the upper limit of this permissible arc voltage is the voltage of the lines supplying power to the lamp.

It might appear on first thought that the arc voltage could be raised to approximately the line voltage. In practice, however, this is not permissible. It is absolutely essential to good regulation of the lamp that the arc voltage should be considerably below the line voltage. The amount that the arc voltage is required to be below the line voltage is dependent somewhat upon the character of the self-regulating mechanism of the arc lamp.

At the present time the searchlights of the navy are adjusted for about 50 volts at the arc. The selection of this arc voltage was dependent largely upon the line voltage of 80. The arc voltage is reduced from 80 to 50 by means of a rheostat in series with the arc, so that it is apparent that a considerable portion of the energy taken from the line is used up in the rheostat.

When the proposition to increase the navy standard voltage was brought up the question was presented as to whether a separate generator of low voltage should be provided for the operation of the searchlights, or whether the searchlights should be operated from 125-volt lines, using a rheostat in series with the lamp. Since the proposition to use a low voltage generator had only in view the saving of the energy dissipated in the rheostat, this proposition was decided against for the reason that the necessities of the service required that a searchlight should, at night, always be ready for instant service, and should always be under the immediate control of the officer of the deck.

In order that this condition might obtain when using special generators of low voltage, it would be necessary to keep these generators running on no load at all times during the night ready for service. The steam consumed by the engines of these generators when running on

no load would very largely exceed the steam required to furnish the energy dissipated in the rheostat when using lines of higher potential.

Notwithstanding these considerations, investigations were undertaken to see to what limits it would be practicable to reduce the voltage of a generator and at the same time obtain an efficient operation of the searchlights. Extended experiments were made to determine the relation existing between line voltage, arc voltage, watts consumed at the arc, and total quantity of light. A description of these experiments, together with the results, is beyond the scope of this paper. It is sufficient to say that the experiments demonstrated that the line voltage could not be appreciably reduced below 80 volts without a bad effect upon the self-regulating properties of the searchlight, and a diminution of its intensity. It was demonstrated that with lines having a potential higher than 80 the arc voltage could be raised considerably above 50, and that the current could then be reduced somewhat without apparently changing the quantity of light.

It was found, however, that with equal illumination, the total energy taken from the line B was greater when the light was operated on lines of 110 and 125 volts than when operated on lines of 80 volts pressure. The increase, however, in the total energy taken from the line was proportionately less than the increase in the line voltage itself.

Operating Voltage on Board Ship.—For the reasons and considerations substantially as given above, it was decided to adopt for the navy a voltage of about 125. It was recommended, however, that the generators on board ship be run normally at 123 volts. Such a reduction from 125 to 123 volts would have no appreciable effect upon the efficiency of operation of any motor or generator designed for 125 volts, and the recommendation was made to run the generators at this voltage on account of the incandescent lamp question. To one not welll acquainted with the conditions under which the navy purchases its material this question may seem of minor importance. In the actual working of the system of supplying the service with incandescent lamps the question is, however, of considerable importance, as the navy has had great difficulty in obtaining satisfactory incandescent lamps. While lamps are commercially made at all voltages from 100 to 125, there are certain voltages between these limits at which the demand for lamps largely exceeds the supply, on account of the large number of lighting plants throughout the country which are run at these voltages. There are certain voltages, however, between these points of concentrated demand where the supply considerably exceeds the demand. In selecting a voltage for the navy, therefore, it was desired to take a voltage very near the commercial standard for generators and motors, but far enough removed from the favorite lamp voltages of large lighting plants to ensure obtaining from stock on short notice such incandescent lamps as might be required. At the present time the demand for 120 and 125-volt lamps exceeds the supply, and this condition will in the future no doubt grow more pronounced. From every lot of lamps made for 120 volts or for 125 volts there are always found lamps of about 123 volts. These lamps are of equally as good quality as the lamps which on calibration give the rated candle power at 125 volts and 120 volts. The voltage 123 is not and probably in the future will not be very largely used as the lamp voltage of lighting plants, and the navy will be able to obtain such lamps quickly from stock.

Practical Working of the System.—It was only last week that an opportunity was offered to test the wisdom of the adoption of the general voltage of 125 and the specific voltage of 123 for incandescent lamp purposes. A collier, the U. S. S. Ajax, came to the Brooklyn navy yard, a few days ago, with her generating set worn out, broken down and of no service. The ship was due to sail in seventeen days. An 8 k. w. commercial, direct connected generating set of 125 volts rating was purchased in the open market and delivered on board ship in ten days, and the necessary number of incandescent lamps of 123 volts rating with limits of voltage from 122 to 124 were obtained in the open market and delivered within three days after the order was placed. Under the old 80-volt system, if no lamps or generating set had been in store, it would have required a considerable time to obtain them, and the ship would have been compelled to sail without a generator and using oil lights.

Conclusion.

While the adoption of the 125-volt system is a long step in the right direction, it must be clearly borne in mind that this is not sufficient in itself to ensure that all the advantages will be secured which might be derived from this circumstance. Having adopted a commercial voltage, the navy must now eliminate from its specifications all special features which are not essential to the efficient operation of its electrical apparatus on board ship. It will only be by so doing that all the possible benefits of the change will be secured.

In closing it may be remarked that the success in quickly fitting out the Ajax mentioned above, was due quite as much to the fact that the material purchased was thoroughly commercial in other respects as to the fact that a commercial voltage had been adopted.—From *The Nautical Gazette*, June 19, 1902.

ENGINES.

HIGH-SPEED ENGINES.

It is certain that the question of high-speed engines has not yet been finally and conclusively settled. The engine so called, became gradually more popular in England during a period extending over many years; but the fact that America and continental Europe have never shown any marked tendency to follow the English lead in this matter as they have done in so many others has without doubt created, if not a reaction, at least a disposition to reconsider the matter in this country. Few engineers can be skeptical as to the new style of engine permanently holding its own for certain classes of work especially adapted to its particular virtues. There is at present a greater inclination toward impartiality of judgment on this question than there was a few years ago. It will be well if engineers generally take advantage of this disposition to try to determine which are the kinds of work which are best served by the competing classes of engines.

In approaching the subject one is always at once confronted with the question, What is a high-speed engine? Unfortunately, the term is quite legitimately used in two senses entirely distinct from each other. The piston speed of an engine is of paramount importance in many respects; but it would be unfair to say that "engine speed" means

necessarily piston speed, while, on the other hand, if the piston speed be high, who could rationally refuse to the engine the title "high-speed"? What is more commonly referred to as "engine speed," however, is its rotational speed, and thus it arises that what in modern parlance we call a high-speed engine nearly always denotes one running at a large number of revolutions per minute. The air would certainly be cleared for more careful and sober investigation of pros and cons if there ceased to be diffused among purchasers of machinery and half-informed engineers the idea that high piston speed generally, if not invariably, goes along with high rotary speed. That it does not do so is well known to all who take the trouble to examine figures. A very high rotary speed is 600 revolutions per minute, and we never find this associated with a greater stroke than 8 inches, and very rarely with so long a stroke. This gives 800 feet per minute piston speed; but, as with one or two exceptions only, all the engines running successfully at such rotary speeds are single-acting, the real effective piston speed is half the above, or 400 feet per minute. Now, double-acting engines with 5 feet and 4½ feet stroke are run without difficulty at 80 and 90 revolutions per minute, giving 800 feet and 810 feet per minute effective piston speed. Any piston speed over 600 feet per minute, and any rotary speed over 300 revolutions per minute, may be termed high. The easier way to get high piston speed is with long stroke and low rotary velocity; the only way practicable to get high rotary velocity is to use a short stroke, and be content with comparatively low piston speed.

What is the merit of high piston speed? The simple elementary aim is evidently to get as large horsepower as possible from an engine of given bulk and cost. With prescribed boiler pressure, piston diameter, ratio of expansion, and exhaust pressure, the horsepower increases proportionately to the piston speed. With any one ratio between diameter and stroke, the horsepower is proportionate to the piston speed and the two-thirds power of the cylinder volume. Thus, under these conditions, the bulk of the engine needed to give a desired horsepower decreases as the one and a half power of the speed is increased. The cost of construction does not decrease quite so fast as in this ratio, of course; but up to certain limits, where high linear speed begins to give trouble at glands, etc., it certainly decreases faster than inversely to the first power of the speed. It should not, however, be forgotten that since, for a given desired horsepower, increase of piston speed lessens the dimensions and thus shortens the stroke, therefore increase of rotary speed accompanies that of linear speed, and at a faster rate—in the ratio, indeed, of the one and a half power of the linear speed. Thus, whatever advantages accompany high rotary speed will appear progressively in a line of engine designs made out for graduated piston speeds, and will do so very markedly.

Up to certain limits high piston speeds bring with them increased frictional efficiency. The disadvantages concomitant to such speeds are indicated by the limits above referred to. They are reached when piston rings begin to heat unduly and when glands get overheated and leaky. With regard to glands, it is too often forgotten that leakage produces heating—directly by the heat of steam penetrating to the body of the packing and indirectly by the escaping steam preventing the lubricant acting on the rod, and thus provoking excessive friction. Other limiting disadvantages are pointed out below; they are common to high linear and rotary speeds.

Let us ask now why high rotary speeds are prized. It is a well-known historical fact that they were first popularized in order to make direct coupling to fans possible. It must not be forgotten, however, that the Porter-Allen engine, exhibited in 1862, was introduced in order to supply a much cheaper and lighter engine than the now old-fashioned beam engine, which was previously in favor. Not only for fans, but for every kind of driven machinery, direct coupling is a very great boon. In some classes of machinery the difficulty is to let the motor run slow enough for direct coupling. An instructive example is that of tramway and railway electro-motors; but very numerous other kinds of slow-running machinery, ordinarily steam driven, will at once occur to every engineer's mind. On the other hand, it is not small dynamos alone that need to be driven too fast for direct coupling to any ordinary steam engine; very numerous classes, such as fans and small centrifugal pumps and many kinds of machine tools, it is quite impossible to direct-couple to the very fastest steam engines, except steam turbines. High rotary speed in steam engines runs from 300 up to at most 800 revolutions per minute. This range covers a very considerable proportion of machine speeds requiring driving power, and with the whole of this direct coupling is a theoretical possibility; but it must at the same time be remembered that a still larger proportion lies outside this range. It must also be considered that with the demand for larger electric powers, dynamos of small diameter and of high rotary speed now occupy a much smaller place on the market than they formerly did.

There are other less apparent advantages of high rotary speed. Chief among these is the diminution of cylinder condensation often claimed, and the consequential important rise in steam efficiency in the cyclic action of the engine. Condensation of steam requires time, and the shorter each period during which the cylinder walls remain cooler than the steam the less should be the proportion of steam condensed. Dryness of the walls is of equal importance, but no mode of jacket heating or steam superheating will, it is held by many engineers, produce this dryness except under the condition that the duration of each period of steam cooling is reduced to the necessary limit.

As high piston speed gives each desired horsepower with correspondingly low driving force, so also high rotary speed gives the same result with low driving torque. Now, in shaft transmission of power low driving torque is a very conspicuous advantage, leading to great diminution of constructional cost all along the line in bearings and brackets, shaft diameter, etc. The economy here is exactly on a par with that obtained in electric transmission by the use of high voltage. The system, of course, labors under the difficulty that it ordinarily involves letting down the speed at the far end, where, at or near the working point, a large torque is essential, and where reducing gearing has to be introduced. The cost in construction and in efficiency of this gearing neutralizes some part of the gain obtained in the transmission, and thus below a certain length of transmission, the advantage of high rotary speed transmission disappears. The limit of length depends upon the conditions required to be fulfilled at the working end.

The troubles common to both high linear and rotary speeds are all connected with accelerations. The most annoying to the mechanic is, without any doubt, the beat at the crosshead and crank pins at the reversal of the stroke. In an ordinary double-acting engine there occur

four reversals of pressure at these joints if the speeds go above a certain limit dependent upon the initial pressure and upon the cut-off. This marks an absolute limit for each engine beyond which no considerations of any kind whatever excuse the raising of the speed. Except under distinctly improper circumstances, there are two reversals per stroke. In the "high-speed" vertical single-acting engine the difficulty is avoided by a top air or steam cushion keeping the joint pressure continuously downward, but this is invariably accomplished only at the price of single in place of double action, and consequent halving of the effective speed, whether that speed be reckoned in linear or rotary units. The harm done by these reversals increases with three things: the number per minute, the amount of the sudden change of pressure, and the slackness of fit between pin and brasses.

The violence of each blow and the number of blows per minute may be taken as each equally influential in the work of destruction. Herein lies the strongest argument against high rotary speed, an argument from which there is no possible escape. For given horsepower one can get high linear speed with a small number of joint-pressure reversals per minute by departing from ordinary ratios between stroke and diameter and adopting long strokes. No similar mode of avoiding the difficulty can be devised, of course, to mitigate the effect of high rotary speed.

Of the three factors, slackness of fit is no doubt the most injurious and the most difficult to find means of avoiding. A tight fit is inadmissible not only because of the resulting friction, but still more on account of an intermittent light pressure being essential to permit the inflow of lubricating oil. Even supposing reform of the usual absurd method of oiling from the center of the bearing area, where the bearing pressure is most intense, to be effected, still no crank pin bearing has ever been successfully lubricated without a large periodic variation of pressure. The key to success in this respect lies in noting that for proper free entrance of oil it is unnecessary for the pressure to go down to zero; it only needs to go to a low intensity. As the pressure intensity goes down, the surfaces, which ought never to be in actual solid contact, but always separated by a film of oil, spring apart and suck in oil. They should never spring so far apart as to break the film of oil. This sucking in of oil does not involve zero pressure, a lowering of pressure below a limit dependent on the capillarity of the oil is all that is needed. At least two makers of double-acting engines have made ingenious, and apparently successful, efforts to keep up continuous contact under slight pressure, while the heavy pressure is alternately thrown on one and the other side, and at the same time to maintain the proper closeness of fit by automatic compensation for wear by the action of springs thrusting the grasses against the pin.

The amount of the sudden change of pressure is, so far as it depends on admission and exhaust of steam, unmodifiable except by adapting steam or air cushioning to the acceleration of momentum of the reciprocating parts. Even such cushioning only modifies the suddenness, it does not, and cannot, affect the amount of change of pressure; it may result in the change being spread over 0.02 instead of 0.01 of a second. Then the balance between acceleration and cushioning can be correct only for normal speed and normal steam pressure; deviation from normal in either respect entirely upsets the balance. The throw of the masses

is generally responsible for the worst of the knock, that is, the centrifugal effects make the worst difficulties. These effects are proportional to the weight of the reciprocating masses, and to a function of the speed which may be expressed either as V N, or N^2 S, or $V^2 \div S$; where V, N, and S are piston speed, rotary speed, and stroke. The last expression shows how all such difficulties are reduced for given piston speed by lengthening the stroke. The first V N, a form of expression too often overlooked, because never found in text books, shows that for given speed of either sort, the difficulty is raised by increasing the other kind of speed; and that the effect is influenced symmetrically by both kinds of speed. The expression N^2 S shows that for given rotary speed increase of stroke raises proportionately these acceleration troubles. Thus large horsepower per unit of bulk of engine is not possible with high rotary speed.

Finally we may usefully compare the engine horsepower with the acceleration troubles arising from the reciprocating masses. The weight of these masses throughout the range of one line of design may be taken to vary very nearly in proportion to the whole steam pressure on the piston, or $p D^2$, while the horsepower is proportional to $p D^2 . S N$ or $p D^2 . V$. Thus the ratios of horsepower to acceleration effect is $p D^2 . S N \div p D^2 . S N^2$, that is, $\frac{1}{N}$. Otherwise stated, the horsepower attainable, so far as it is governed by centrifugal troubles, is inversely proportional to the rotary speed. This result, which has not been commonly observed, indicates perhaps as clearly as any other what are the limits of usefulness of high rotary speed in engines of the piston type.

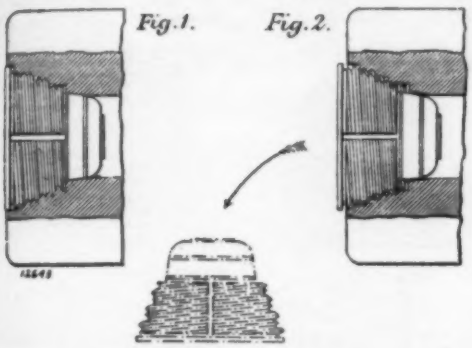
The same ratio $\frac{1}{N}$ may of course be written $\frac{S}{N}$, which shows that such troubles are of worst influence on small engines, and that to keep even with them in passing from large to small sizes we would need to reduce piston speed in proportion to stroke.

GUNS.

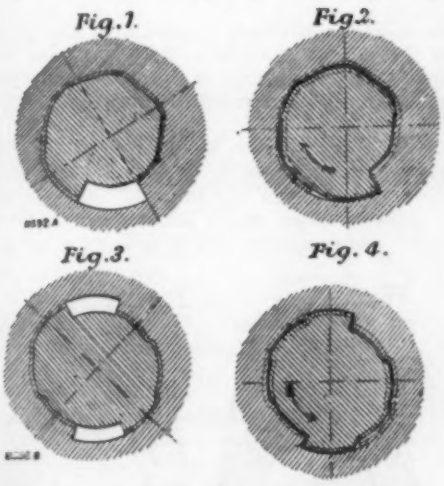
NEW INVENTIONS, BREECH MECHANISMS, FUSES, MOUNTS, ETC.

BREECH MECHANISM.—Breech mechanism for ordnance according to this invention comprises a breech-block formed longitudinally with a series of steps, each of which has screw-threaded segments of different radius, the breech being correspondingly formed so that when the block is inserted each cegment thereof enters a part of the breech of slightly greater radius, and can by a partial rotation be caused to engage with the corresponding threads of the same radius. The difference between the height of the different circumferential segments should be at least equal to the height of the thread. In addition to the number of threads used for securing the block—for example, two—an additional half thread may be added at the rear of each threaded portion in order to avoid the formation of a sharp angle between the back of the thread and the front of the next higher stepped portion.—*Engineering*, June 27, 1902.

BREECH-LOADING ORDNANCE.—In order to obtain a small increase of thread area in breech-blocks of the stepped kind, with a consequent decrease in the length of block necessary to withstand a given strain; according to this invention the line from step to step is not terminated



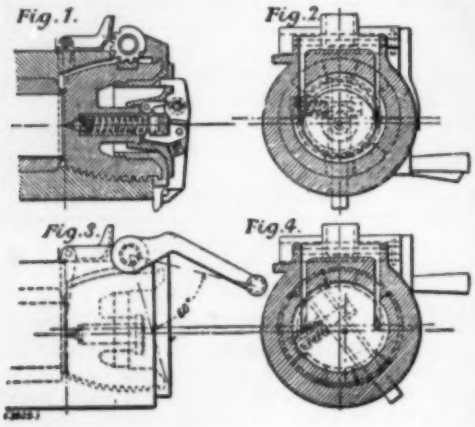
abruptly with cessation of threading upon a radial surface connecting the steps, but the steps are sloped up one to the other, and the whole surface of the block, except upon that radial connecting the lowest to the highest step, is threaded. In such blocks the strain is well equalized, and, it is



stated, there is not the weakness under a slightly imperfect closure that is characteristic of conical blocks regularly threaded.—*Engineering*, June 20, 1902.

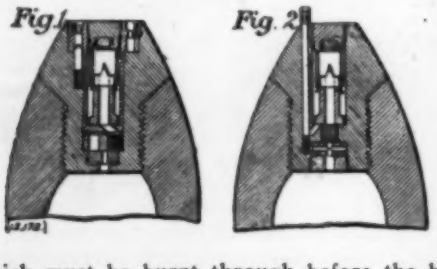
GUNFIRING MECHANISM.—Should a centrally-mounted firing-pin remain protruding after the gun is fired, either by reason of deformation or as a consequence of fouling, premature ignition of the charge next introduced into the gun is likely to occur. In order to avoid this risk the firing-pin

is according to this invention so disposed that until the breech-block has been turned into the completely closed position the firing-pin faces the blank metal of the cartridge back, and not the detonating cap. In one arrangement the breech-block, which opens to the rear, is so located in the breech-piece that its central line stands eccentrically to the central line of the charge chamber. The striking-pin bearing is so arranged



that when the closing is effected, it stands in the prolongation of the central line of the charge chamber. By the rotary movement of the breech-piece the firing-pin bearing is turned eccentrically on the middle line of the breech-piece.—*Engineering*, June 13, 1902.

PERCUSSION FUSES.—Percussion fuses either to fire on impact or having delayed action are according to this invention constructed with two passages between the igniting chamber of the fuse and the bursting charge, one of these passages being adapted normally to provide direct communication for instantaneous action and the other having a combus-



tible charge which must be burnt through before the bursting charge can be reached, the directly communicating passage being provided with means for moving it out of communication or of stopping it up should delayed action be required. The directly communicating passage may contain the explosive which can burn to strengthen the flame from the detonating composition.—*Engineering*, May 23, 1902.

GUN-MOUNTINGS.—This invention provides means for controlling the running-out rate of movement of guns provided with hydraulic recoil buffers and recuperators for running them forward after recoil; the trunnion bearings of such gun-mountings are also improved. The recoil brake has a hollow piston-rod and a central ram, one of these parts having one or more taper grooves or passages to act in combination with one or more uniform grooves or passages on the other part. In

Fig. 1.

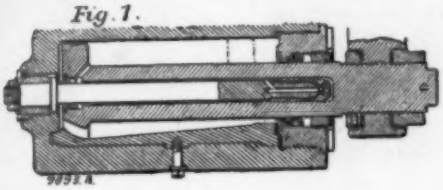


Fig. 2.

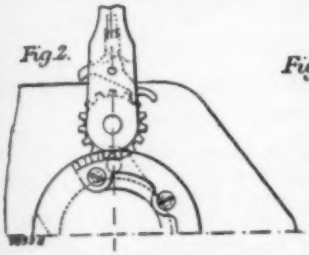
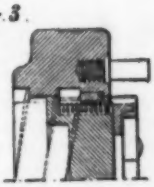
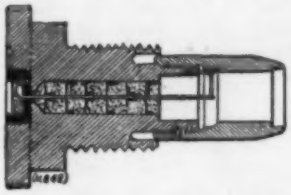


Fig. 3.



connection with the improved trunnion bearing means are provided for preventing the attachment or detachment of the implement employed for rotating the trunnion cap unless the caps are in proper position. The trunnion cap has a toothed segment and a mask provided with a gap or aperture, and is automatically locked immediately after the detachment of the actuating implement.—*Engineering*, June 6, 1902.

PRIMERS.—This invention has for object to provide means for insulating the conductor of an electrical primer and preventing escape of gas therefrom. The body of the primer has in it a cylindrical cavity, through which the conductor is led axially, insulated by means of discs of asbestos or the like threaded onto it and fitting the cylinder. Two sets of gas jets are introduced at intervals, one to prevent gas from passing along the wire through the central holes in the discs, and the other to prevent it from passing between the circumferences of the discs and the wall of the cylinder. The check first mentioned consists of small metal tubes fitting onto the conductor and having external flanges at their rear ends, whilst that last mentioned consists of metal tubes fitting inside the cylinder and having internal flanges at their rear ends. The gas-checks of the two sets are preferably arranged alternately and at such intervals as to prevent any risk of short-circuiting between their flanges, and pressure is applied after each gas-check is put in place. The body



of the primer has at its rear end an enlarged head, and its front end, reduced in diameter, has a screw thread cut around its exterior, upon which a cap or prolongation can be screwed. From the rear end of the cavity is a passage of smaller diameter to the rear of the body, and at the extreme rear end of this passage is a shallow cavity of larger diameter, intended to receive a disc of ebonite or other non-conducting material through which the conductor projects. The recess is filled in with melted soft metal so as to make connection with the conductor. The front end of the conductor has soldered to it a platinum wire that is also soldered to a pin projecting from the front end of the body, the finished primers being surrounded with guncotton. A metal prolongation open at the end is screwed onto the body, and the cavity is filled with powder or composition and closed with a cork disc and shellaced. It is stated that primers constructed in this manner can be re-wired and primed many times without destruction of the insulation.—*Engineering*, June 20, 1902.

GUNNERY.

THE RECENT BELLEISLE EXPERIMENT.

By Fred. T. Jane.

The Belleisle has been fired at again, the object of the experiment being in the main somewhat on Euclid's Q. E. D. lines, or proving that one and one make two. The objects were:

(1) To ascertain the effect of lyddite on a conning tower.

(2) To ascertain the effect of the same shell on torpedo nets.

In the first case the experiment was invalid owing to the Belleisle's conning tower being of a now unused pattern. That is to say, it is a circle entered from below. The modern tower is as shown herewith. In the Belleisle the gas had, therefore, only the top of the tower to act against. A caged rat placed inside survived—its reported death is a picturesque touch of description. Being below the rush of gas level, an air cushion might to a certain extent be expected, and direct concussion was not experienced. A man, on the other hand, would have been looking over the top of the armored circular wall, and his head in the full path of a blast far exceeding in force any hurricane that yet blew, and in temperature equaling, if not exceeding, white-hot iron. In a word, the equivalent of a blow from a white-hot steam hammer would be encountered. The result is one that pure theory is hardly likely to go astray over. Incidentally it has been "proved" that life may exist in a hole under these conditions, but any Boer who was at Paardeberg could have told that much.

The experiment was invalid to the extent that with a modern tower the rush of gas would follow the line of the arrow in the diagram shown, and so enter the tower directly. This is important in so far as the first effect of a hit on the tower must be to hurl to the deck every one inside. The distance to be traveled by a head, from sight to cover, is so small that between the hit and the rush of gas a man might get out—or, rather, be flung out—of the direct path of concussion before the rush of blast came. With the modern tower, having side inlets, this chance will be taken from him probably, unless the angle to be followed tends to mitigate things, which is hardly likely. In any case, the tower fired at was not the tower we use. It may be instructive to note that

it is the pattern the French employ, and all that we have yet done with the Belleisle the French have done years ago. If our Intelligence Department has soared at all beyond "scissors and paste" it is familiar with these things; and we are doing no more than "proving proofs." French ships have often three primary fighting positions, but for a long time there has been a feeling that the conning tower is, like the ram, a survival of obsolete ideas. It is an amateur idea at the best. It dates from the days when the shot that made a hole was the only projectile thought about, and that was never the only actual danger. Concussion killed men back in the days of the American Civil War, and to realize that the blast of a shell might cause concussion of the atmosphere was no gigantic step. The conning tower antedated these experiences, and has existed ever since without any very integral change in conception. Logic demands, and always has demanded, something in the open, and out of the Belleisle firing we may get it if the Admiralty have the courage of the progressive views they now seem to entertain.

Over the Belleisle's conning tower there was a bridge. This was brought down. It was made into a scrap heap, splinters and dust. The ideal tower cannot, therefore, be on a bridge. I may indicate what it may become if only progress can be given free rein.

Let us now proceed to examine the ideal conning tower, or, rather, let us say the conning tower that offers most chances of survival to the users of it. In diagram form "ideal" may apply to it, but an inspection of the second picture—which is based on what is known of the actual effect of gunfire on ships—will show that the absolutely ideal position cannot exist. Advantages can be relative only. An important point to remember, too, is the almost night darkness in which battles will be fought. Apart from the smoke from pierced uptakes, walls of blackness due to the dust that flies from coal bunkers at every hit may be looked for, and this may be an intolerable nuisance; though it is a point to which absolutely no attention has been given.

To return, however, to the diagram. The conning tower is essentially the ship's brain center. It contains:

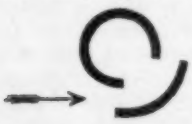
(1) The steering wheel.
(2) Voice pipes, telegraphs and telephones to all parts of the ship.
(3) Indicators from the engine rooms, etc.
(4) The torpedo tube directors.

Now, the first question is: Are these things essential—need they all be in the conning tower? The answer to this is: In some form, yes. The wheel may transmit to a steersman below; but, since it must be under direct control of the captain, some one must be close to him to manipulate it. If he be beside the captain, he is to that extent in the way. His life is very valuable, for if he be killed the ship may drift for the few instants necessary to make her fall off, lose the fire of one or two guns, and perhaps the day. It must ever be remembered that in the naval battle of to-morrow, not merely the minute, but the second, will be a factor of urgent importance. Ergo, it is necessary that the steersman live, and that a replace-man be in a position of safety to take his place instantly. As will be seen from the diagram—which embodies as far as possible all the latest ideas in this question—the quartermaster is below the captain, in a safe post, his replace-man below again. This steering post is in direct communication with the captain, who may either call down through the communication hole, or use the indicator. This is manual, so as to run the least risk of being put out of order.

It may also communicate with a third wheel below water—an idea embodied in many ship designs for a long time.

The voice pipes will be a series of holes sunk in the armored floors, so that they cannot be shot or shaken away. They will be duplicated with electrical transmitters, also sunk in the floor.

The disposal of engine-room indicators affords difficulty. Probably large ones, well in view, placed well away, will be best, but there is a field for invention here. I am not at all sure but that some system of throwing the revolutions onto a black screen by means of some automatic magic lantern arrangements might not be of value. Indicators, as they are, will be knocked over if the tower be hit, and since towers will be aimed at, and since it is the insane practice to place near them a mast—which serves to lay hostile guns by—towers seem likely to be the centers of many explosions. There are pretty theories of discriminating fire; in real battle it is the foremast that every gun will be laid on. If only 1 per cent hits are secured, bursts on or near the tower will be frequent. In the only naval action fought on scientific lines, the engagement between the Chilian Blanco Encalada and Almirante Cochrane and the Peruvian Huascar, the Huascar was primarily done for by conning tower attack. Everything inside was smashed by the shock of outside hits even in those primitive days. In the Belleisle the smashing was still greater.



Torpedo directors might, I think, be elsewhere than at the tower. They are not needed early in the action. They have hardly the ghost of a chance of survival as now placed. The feeling is that they should be in some spot less likely to come under fire. In all cases they need placing in duplicate, or, perhaps, in armored boxes, from which they can be extended when needed. In this form they might be on the conning platform.

Finally, no boats, guns, masts, funnels, cowls, rigging, or any other shell-bursters must be near the tower, but well away, boats in particular being below the splinter nets.

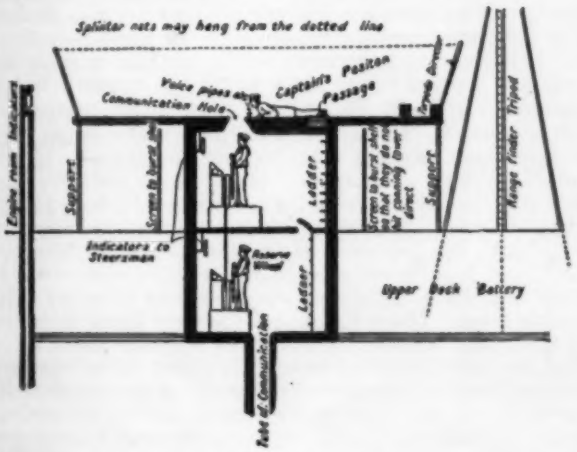
Two other accessories demand attention. Range-finders are placed on chart houses on the bridges. The Belleisle has indicated—were indications needed—of what use a range-finder so placed will be. Since it must be high up to get a clear view, it should, I think, be on a special tripod grating, clear of everything, the operator lying on it, and communicating ranges with a transmitter. Singing out the range is no use—it will not be heard. It is not heard properly even at target practice, the noise of which is a trifle to a battle noise.

The other accessory is signaling. In action there will be little, still it may be badly needed in the *final* stages. In the early stages it will be comparatively simple. Now we know from Yalu that all halyards are likely to go, and the first Belleisle experiment gave no promise of the survival of even light masts.

Two methods have been seriously suggested. One in a small captive balloon to which flags may be hoisted and cut away and sacrificed when done with, the other concerns colored shells for simple signals. This latter may be the best. In any case the admiral must have them under his control. So must the captain. Guns placed elsewhere can be discharged by buttons in the armored floor, and admiral and captain will probably be together. The idea of these colored shell sounds a little strange, but it is the only thing that seems practicable under the condi-

tions of modern gunfire. The present Belleisle firing has shown that signalmen on a bridge will remain for a very little while, hence a substitute must be found for use under fire.

A tower such as I have indicated seems liable to only one main danger—Maxim fire. But Maxim range is not likely to be reached. A bulwark to protect against Maxims might be embodied, but it would all too probably grow to be a shell burster, and so bring us back to present evils. The captain must, I think, lie flat on his stomach, and chance such target as he offers thus. He will be safer so than inside even three feet of armor. It is not bits of projectiles so much as torrents of atmospheric hurricanes that he has to fear, and these he will surely avoid best by being in the open where shells will not burst near him. In diagram form that is his only danger, but the study of a pictorial realization of the same thing shows that "bits of ship" are by



no means negligible factors. Still, splinter nettings may do much, while a further gain will be that, though not obstructing the view, they will prevent the otherwise probable contingency of the captain being blown off his platform by the shock of his own guns.

I put forward these remarks in the hopes of drawing careful attention to this vital question. I do not claim it as a best possible. But I do claim that it faithfully illustrates a trend of naval thought, needing a consideration that it does not receive. The Belleisle has proved clearly enough that the conning tower, as anticipated, is a totally useless contrivance in its present form. It is absolutely essential that the captain exist, the hard question is—How?

Another portion of the experiment was devoted to torpedo-net defense and its behavior under fire. Its behavior again was as anticipated—it was blown all to pieces. The shells tore it apart, flung and drove it all over the ship, and generally totally destroyed it. The blast burned up everything that could be burned. This is quite new. Lyddite has a solid reputation as being a non-burning explosive, and the only explanation I can offer is that some new form of it, or some other new high explosive, was used. Whatever it was, the ship's side was a mass of

flame, and when it passed every rope had gone with it, and many smaller wire ropes were melted. At one stroke, therefore, torpedo-defense nets are put out of court, for if ever they are wanted it will be after an action. This means that some protection must be evolved, or else the old plan of carrying nets inboard resorted to, unless, as is by no means impossible, we resort to fighting with them down. This will entail a heavy loss of speed and all tactical speed advantage, but speed as a purely tactical asset has little value save for peace manœuvres in which admirals make cheap reputations. So many things will reduce it in war that a loss right away may signify little. Torpedo craft, submarine or otherwise, will be such a terrible danger to ships in the heat of battle and at the end of it that almost any sacrifice may be needed to guard against them.

Thus, then, the main conclusions and lessons to be drawn from the last Belleisle experiments. There are other minor lessons that I do not think it well to discuss. The main issues are too obvious for any secrecy to be worth maintaining, for any one could have foretold most of them. Still between a forecast and a realization there is always a difference, and "prove all things" is by no means a bad motto for naval warfare.

The main regret is that the effect on personnel was not better gaged. A rat is not a man, nor can a rat record experiences. It is these that we so urgently need. To try and obtain them with dummies is vain. A dummy very poorly indicates the atmospheric effect; and though the dummy captain of the Belleisle was "shot through the heart" by a piece of stray splinter, this was pure accident and chance. Human observers are needed, and I am quite sure volunteer lieutenants could be secured by promise of promotion, say, to commander at once and captain at the first possible time. There is, did people only know it, a deal by way of precedent, only hitherto it has been without prizes. Thus in the Chino-Japanese war a British torpedo lieutenant served "for experience" in a Japanese boat attacking Wei-hai-Wei—of course unofficially. Officially, artillery officers were put in more or less dangerous posts of observation at the Steepholm experiments, and much valuable—and unsuspected—information acquired. More recently something of the sort happened in the Channel fleet, only then those experimented on were not informed of the scope of the experiment. Then, too, at Portsmouth, when a boom was rushed the Admiralty insured the lives of all concerned, which marked the risk. Knowledge cannot be acquired without it. A hundred years or so ago the condemned criminal would have been used with freedom as the prize of survival; to-day, apart from sentiment, the observations of such a one would be no good. There are plenty of gunnery officers able to give the necessary ability, and there is no reason why they should be killed to a certainty; or, if they were, then we should learn that the big ship is obsolete. We have everything to learn in this respect, and even the effect in quite some other part of the ship to that hit would be learned with advantage. The wildest theories are afloat concerning the deadly effect of lyddite both as an asphyxiator and as a cause of concussion and heat. The heat can be gaged by metal or thermometers, the concussion effect approximated by mechanism, but vaguely only. The asphyxiation effect can equally vaguely be guessed at from the effect on animals, but this is not a sure guide, and in any case, as I have said above, animals cannot relate their experiences, nor would medical examination go for

much. The effect on brain and nerves cannot be thus represented at all. Yet there are scientific men who assert that, in the confined space of a ship a single 6-inch lyddite shell may incapacitate nearly every one. Will it, or will it not? It is of urgent importance that we should know; and the Belleisle has given so far a very undecided answer, even when surmise based on vague indications is accepted as proof. Before the old hulk is done with we shall have to solve these problems, and the human observer will have to be on board her. Probably he would have been already but for the sentimental outcry that any fatal termination might have led to. The only way to meet this is to prepare the public mind for it; for it is useless to pretend that the necessary experience could be gained without grave danger to the observer. But without this observation the experiments must remain incomplete. There is too much tendency to ignore the human element in these sort of trials, for the cardinal question must ever be not the effect on *materiel*, but whether the personnel can survive. If so, the damage to the ship matters little; while the crew exist she can still fight. If the crew be killed or stricken with panic or physical incapacity, then most of our naval architecture is vain. It has often been prophesied that the doom of the big ship will come over the invention of a projectile, one single hit from which will annihilate. The future in these matters may be left to itself. The problem is: How far is that stage already reached? Probably it is not reached. But we do not know. And because it gives no answer, because it tells us all that we could have guessed, but nothing of what we cannot guess, the Belleisle experiment remains incomplete, and to that extent unsatisfactory.—*The Engineer*, August 8, 1902.

PREMATURE EXPLOSIONS IN QUICK-FIRING GUNS.

By a Gunner.

The serious accidents which have repeatedly occurred during the last couple of years in England, France, Russia and Sweden from premature explosions in quick-firing guns of larger calibers necessitate reliable explanation as to their cause and thorough research of means for their prevention. It is urgent that this should be done at once, because such accidents will evidently occur more frequently when the guns become worn by long service. Full light should be thrown upon all surrounding circumstances, without too much consideration for the feelings of constructors, and without giving too much weight to the question of cost of changing the present systems in case these should be found faulty. If due explanation of the faults and of the means by which they can be corrected is too long deferred the change ultimately will become more expensive, the greater the number of guns of unsafe types that are meanwhile acquired, with the risk, of incalculable importance, that the gunners may become afraid of their own weapons.

The first step towards increased rapidity of fire was the adoption of breech-loading guns in lieu of the old muzzle-loaders. Many countries started with their own constructions of breech mechanisms, but since the French breech screw, with interrupted threads and with De Bange's gas-check, proved superior to Krupp's wedge, to which De Bange's system could not be applied, most countries have, like England, adopted the French type for ordinary breech-loading guns of calibers from 3-inch upwards. Next to the mitrailleuses, or machine guns, real quick-firing was first carried out in smaller single-barrel guns up to the 6-pdr., and

the constructors of such guns gained the special detail experience of all the precautions which were found imperative for the safety of quick-firing guns using metal cartridges carrying their own means of ignition. For such smaller guns no trouble has therefore arisen from the use of metal cartridge cases, but when the necessity made itself felt to increase the rapidity of fire also of larger guns the difficulties commenced, several countries having tried to retain the interrupted screw in order to save expense, while inserting into it new firing arrangements and other modifications expected to suit quick-firing with metal cases.

This led to repeated accidents, and this system soon proved itself unsafe and unsuitable for quick-firing, when the powder charges were put into metal cases, and for the following reasons:

(a) The breech screw, on being pushed home with considerable force, strikes the base of the cartridge case so hard that the primer can be ignited by vibration; it has been proved that when a blow strikes the base at certain distances outside the primer the wave of vibration is almost sure to ignite certain types of primers.

(b) The firing pin in the center of the breech screw is always in line with the primer in the cartridge case, when the breech screw is pushed home; if the firing pin is fixed with its point outside the face of the breech screw (in case the firing pin is broken or held in that position by powder, dirt, or from other causes), the primer is struck and ignited by the protruding firing pin, before the breech can be safely closed by turning the screw into the threads of the gun.

(c) Recent official trials have proved that if the firing pin is not thus fixed, but rests free in its groove with the point protruding, the primer is nearly always ignited by the inertia of the firing pin, held forward by the initial pressure of its spring, when the breech screw is pushed home with force against a cartridge case fully inserted into the chamber. The firing pin can often be inadvertently left in this position, if it has slipped off the trigger comb; when certain parts of the mechanism may be broken; when the spring may accidentally not have been armed, etc.

(d) It may be said that accidents of this kind do not often happen, but they are sure to become more frequent when the guns become worn, and there appears to be no justification for continuing to make or purchase guns of a system which almost seems to invite accidents.

(e) Electric ignition for quick-firing guns with interrupted screw does not diminish the risk, because the contacts are also in line before the breech is closed, so that failure of electric action will cause ignition and premature explosion.

(f) In case of ruptured cartridge cases or pierced caps the interrupted screw does not allow of sufficient space for the escape of powder gases.

(g) Whenever premature explosions do occur before the breech is safely closed the accident becomes more disastrous, because the breech screw is held only by its hinge, and all the parts of the mechanism are projected out of the gun like so many projectiles.

(h) The inconvenience already experienced in ordinary breech-loading guns of this system of opening the breech by swinging the mechanism outside of the gun becomes still more serious with quick-firing; when the vessel rolls the breech screw is apt to swing to and fro like a banging door, with much risk of jamming the hands of the gunners.

For larger guns, above 6-inch caliber, metal cases may, perhaps, become too costly and quick-firing anyhow difficult. In such guns the De Bange gas-check gives much satisfaction and the risk of premature

explosions can be minimized by introducing into the mechanism means of manifold safety, which with ordinary rapidity of firing there would be plenty of time for operating.

The most important question for the moment is how to make quick-firing safe in medium-sized guns, calibers from 3-inch to 6-inch. Pending definite decision upon this question, it has been suggested as a necessity to reduce the rapidity of firing by instructing the gunners to avoid all quick and violent movements; this seems to be an unreliable makeshift, as such instruction will soon be forgotten when the gunners are exposed to the enemy's fire. It has also been proposed to use the De Bange breech without metal cases, but this makes any attempts at real quick-firing quite futile and gives rise to other serious disadvantages. There will always be the danger of burning particles left in the chamber, unless it is carefully sponged out after each shot.

The accident on board the Mars, where metal cases were not used and ignition was effected by electricity, shows the danger of the silk bag, in which the powder charge was enclosed, being insufficiently ignited and left smouldering, until it flamed up on the access of air when the breech was opened. When a metal case is not used it is more difficult, and takes longer time, to ascertain that the projectile is fully home, failing which the erosion becomes greater, and it is possible that a shell with double-acting fuse may explode in the bore of the gun. The metal case is of considerable assistance for pushing home the projectile, and anyhow prevents the breech from being fully closed unless the projectile fully bears against the rifling. The powder cannot be so well protected in other ways as in metal cases, and upon thorough investigation of the entire question it will probably be admitted that the use of metal cartridge cases is, perhaps, the most important part of a really effective quick-firing system.

Many attempts have been made in recent years to solve the problem, and it is of interest that, while France was the first country in which the De Bange gas-check was used, that country seems again to be first in adopting into its army as well as its navy the apparently safest breech mechanism for quick-firing guns with metal cases in the excenter screw breech mechanism which has been adopted for the new French quick-firing field gun, and which—like De Bange's breech—will probably soon come into general use in most countries.

The leading features of the system are said to be the following:

(1) The breech block is not pushed forward against the cartridge case, which is wedged into its proper position by the sloping surface of the excenter screw, thus removing the risk of premature explosion by vibration during the loading operation.

(2) The firing pin can never, even accidentally, be brought into line or into contact with the primer until after the breech is so far closed that no accident can occur from the firing pin accidentally striking the primer, or when fired electrically, from faulty electric action.

(3) There is consequently no necessity in the firing mechanism for any safety gear, which might be apt to get out of order or inadvertently become inactive.

(4) No risk is incurred from using metal cartridge cases carrying their own means of ignition if the primer is covered by a safety clip, which is removed only at the time of loading, or if the primer is inserted into the case after this is brought to the gun from the ammunition magazine.

(5) The powder charge is thus fully protected.

(6) As the breech cannot be closed until the projectile is pushed home by the metal case, the erosion will be the smallest possible, as well as the risk of explosion of shells in the bore of the gun.

(7) In case of a ruptured cartridge case the powder gases are free to pass out through the open space, into which the breech-block is turned when the breech is opened.

(8) The excentric breech block always remains in the breech with as large a bearing surface for the threads when the breech is open as when closed; in the improbable case of premature explosion, the only piece that can be projected to the rear is thus the base of the metal case.

(9) The mechanism occupies no more space when open than when closed and there is no inconvenience for the gunners in a sea way.

(10) The excenter screw is used for several calibers, from that of field guns up to 5-inch and 6-inch.

The cost of metal cartridge cases over and above that of other means of protecting the powder charges, in the magazine and when carrying them up to the guns, is not of such great importance as has sometimes been said, because old cases would mostly be used for gun practice in time of peace. Anyhow, metal cases are better means of obturation than even De Bange's gas-check. Perhaps the best argument in favor of mechanisms in which the cartridge cases are not subjected to blows and the firing pin is not brought into line with the primer until after the breech is closed, is the fact that while other countries are hesitating to use metal cases with the interrupted screw, Germany is said to contemplate the adoption of such cases for even larger caliber than 6-inch with Krupp's old wedge mechanism, which offers these two advantages, though in other respects not free from drawbacks.

If upon thorough investigation the above statement of the principal features of the excenter screw mechanism proves correct, that gun may be said to offer the greatest security against accidents, as its safety depends entirely upon the construction of its mechanism and is independent of any breakage of its parts, and of any failure of the gunners to follow instructions; or in other words, that the gunners cannot inadvertently make it dangerous for those who serve it.—*Army and Navy Gazette*, August 8, 1902.

LIQUID FUEL.

LIQUID FUEL FOR STEAMSHIPS.*

By EDWIN L. ORDE, of Newcastle-upon-Tyne.

The subject of this paper is one which has already received so much attention that it is difficult to-day to contribute anything which possesses much value. A close examination of the literature which has appeared on the subject, however, seems to show that, from some cause or another, the many undoubted advantages which liquid fuel offers have either not been fully appreciated, or, if appreciated, not pursued with sufficient determination to insure that they shall be realized in actual practice. The explanation of this would appear to be that until comparatively lately liquid fuel was not obtainable in such quantities as are required to make it commercially useful.

*Paper read before the Institution of Mechanical Engineers.

Fig. 2. Swenson Burner.

Fig. 1. Körting Burner.

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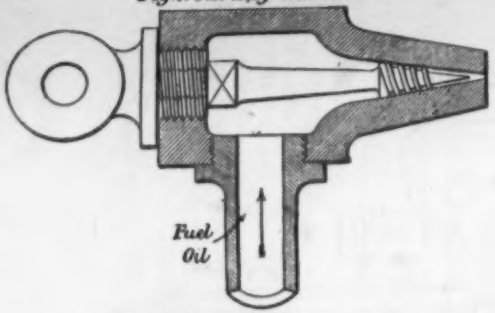

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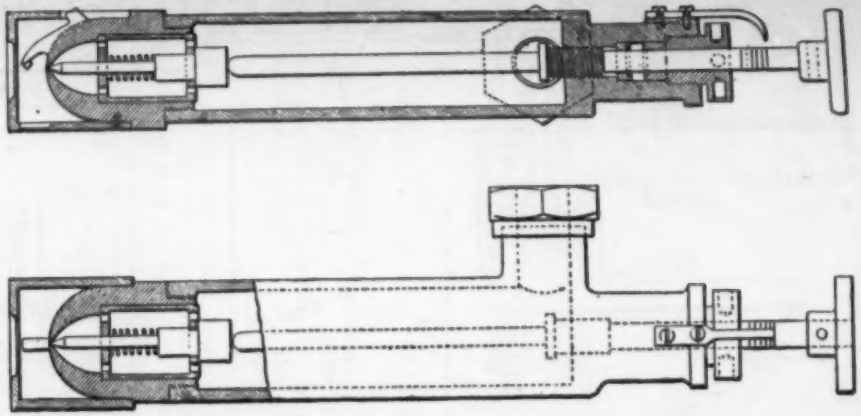
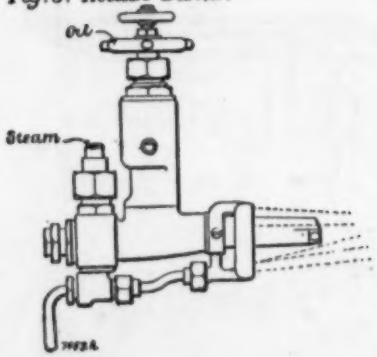


Fig. 3. Holden Burner.



Enlarged Views of Tongue Sprayer.

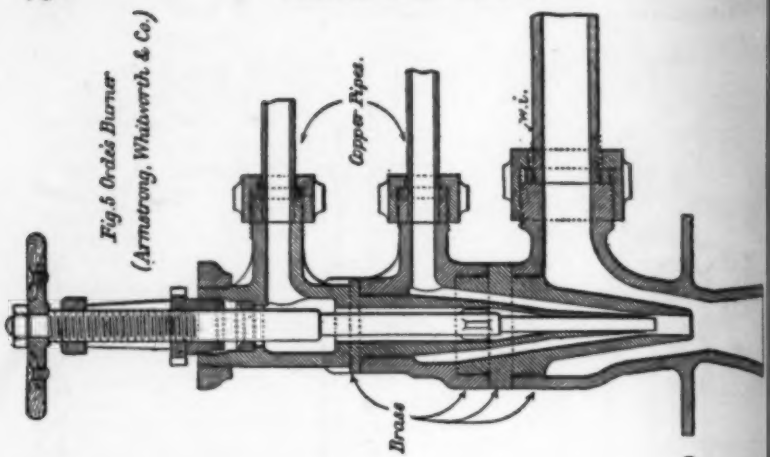
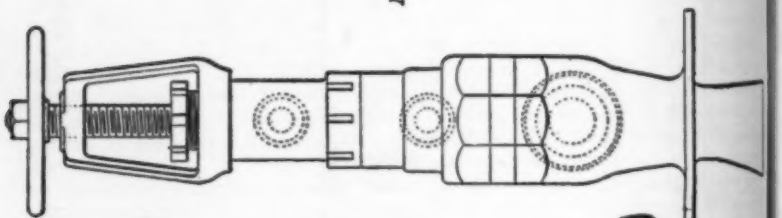


Fig. 5 Orde's Burner (Armstrong, Whitworth & Co.)



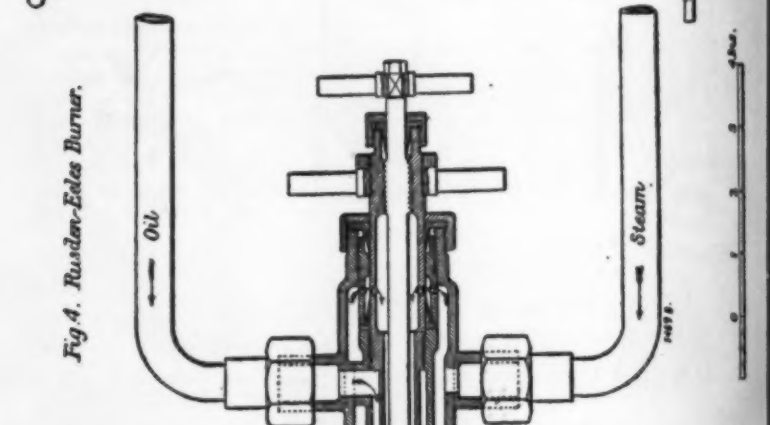


Fig. 4. Rusden-Eden Burner.

For many years the Caspian Sea was the only place where liquid fuel was used in the furnaces of marine boilers, and, as the quantity available was not sufficient to allow of its export, it could only obtain a very limited application. Of late years, however, the sources of supply have largely increased in number, and now that the large oil fields of Borneo and Texas are in active operation, and commercial enterprise only needs the stimulus of demand to organize distributing stations, the question of the adoption of liquid fuel on a large scale appears to need for its solution only the close attention of engineers. The principal sources of supply are the fields of Borneo, Burmah, the Caucasus, Texas, and California; but there appear to be indications that further supplies exist, and, were the demand assured, would be explored and developed.

The subject seems to fall naturally into four divisions:

1. The characteristics and calorific value of the various forms of liquid fuel at present available.

2. The general conditions which govern its combustion in boiler furnaces.

3. The various types of apparatus which have been designed for utilizing liquid fuel.

4. The actual results which have been obtained.

Characteristics.—The composition of petroleum is in itself a study which demands special knowledge, and only the features which are of importance from the point of view of combustion need be considered in this paper.

The composition of petroleum is exceedingly complex, but as some of the phenomena which present themselves in using it as fuel are purely chemical, some attention to its principal characteristics is essential to the proper consideration of the subject.

Petroleum consists of a number of hydrocarbons, which occur in the following series:

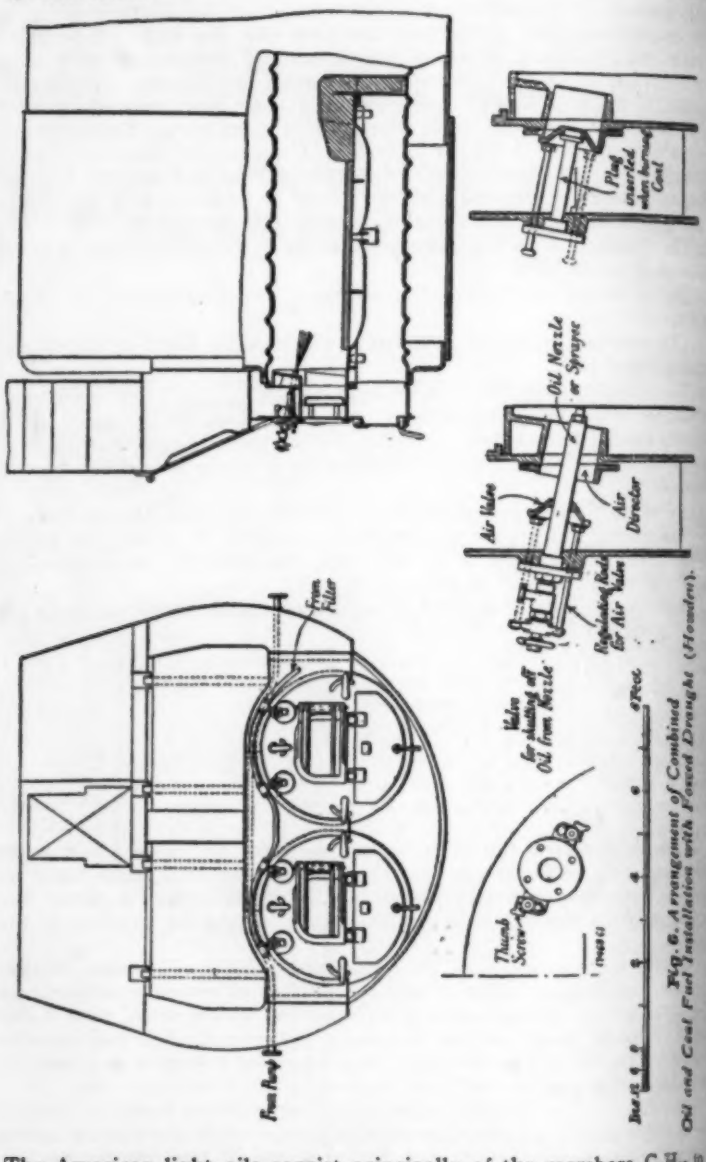
1. $C_n H_{(2n+2)}$	**Methane.**
2. $C_n H_{2n}$	**Olefine.**
3. $C_n H_{(2n-2)}$	
4. $C_n H_{(2n-4)}$	
5. $C_n H_{(2n-6)}$	**Benzine.**
6. $C_n H_{(2n-8)}$	
7. $C_n H_{(2n-10)}$	
8. $C_n H_{(2n-12)}$	

Of the eight series, the first, second, and fifth are those which occur most frequently and in the largest proportions, and as of these three the first or Methane series is probably the most important, a short consideration of its characteristics will be sufficient for the purpose of this paper.

The first four members of the series are gaseous (Methane, Ethane, Propane, and Butane), when in contact with air at ordinary temperature. The liquid members begin with $n = 5$ and end with $n = 25$; with higher values of n the members are semi-solid (paraffins). The boiling-point rises fairly regularly with the increasing values of n from $n = 9$ upwards (each additional carbon atom representing a rise of about 20 deg. Cent.), as also does the specific gravity, although the increase is not so regular.

The crude petroleums as they come from the wells are usually refined by a process of distillation, and the products of the process may be roughly divided into three groups:

1. Light oils, distilling over up to 150 deg. Cent.
2. Illuminating oils, distilling over up to 300 deg. Cent.
3. Residuum.


Plug unscrewed when burning Coal
Oil Nozzle or Sprayer
Air Valve
Air Director
Regulating Rod for Air Valve
Valve for shutting off Oil from Nozzle
From Filter
From Pump
Thumb Screw
4 Feet
Fig. 6. Arrangement of Combined Oil and Coal Fuel Installation with Forced Draught (Howden).

The American light oils consist principally of the members C_8H_{18} to C_9H_{18}, and the illuminating oils C_7H_{16} to $C_{16}H_{34}$ of the Methane series.

The residuum can be subjected to higher temperatures when it yields (*a*) heavy oils which produce lubricating oils and paraffins, and (*b*) carbon in the form of coke.

The members of the three groups are further subdivided into about 20 for trade purposes. The specific gravities of the three groups are approximately:

Light oils	0.65-0.78
Illuminating oils	0.78-0.86
Lubricating oils	0.86-0.96

No further consideration of the refining of the crude oils would be necessary were it not for two very distinct processes of distillation, both of which present phenomena which exert an important effect on the behavior of liquid fuel when treated in the burning apparatus.

These are:

1. The "cracking" process.
2. Illuminating oils, distilling over up to 300 deg. Cent.

The "cracking" process consists in distilling over the lighter oils at temperatures above those at which they would boil under normal conditions. This is effected either by allowing the products of the distillation to condense and fall back into the contents of the still, or by distilling under pressure. The effect of the process is to decompose the heavier oils remaining in the still and materially decrease their specific gravity. The oil resulting from this process becomes more homogeneous in its composition than before; but if the temperature in the still reaches too high a point, solid carbon is deposited in the form of coke. These deposits of solid carbon, unless careful attention is paid both to the temperature to which the still is exposed and to its design, form a large proportion of the residuum after the lighter oils have been taken off; and continuous distillation on the "cracking" principle seems to be impossible owing to the rapid increase in quantity; but in the presence of steam, on the contrary, it appears to be possible to distil practically the whole of the crude product. One explanation of this phenomenon that has been given is that steam has the property of lowering the boiling points of the hydro-carbons with which it is brought in contact, and therefore allows them to volatilize at temperatures below those at which the cracking process sets in. Superheated steam is generally used in order to attain the temperature required for distillation, which reaches 550 to 600 deg. Fahr. in many cases. Air does not possess this solvent property, nor is it so convenient a vehicle for the heat required in the process of distillation. This part of the subject has been dealt with at some length, as the process of presenting the liquid fuel in boiler furnaces in the most suitable conditions for combustion is in many respects an analogous one. Before complete combustion can take place, the fuel must pass from the liquid to the vapor form; and it is obvious that the most successful apparatus must be that which accomplishes this object with the smallest expenditure of heat. The fuel oils in general use are the crude oils of Borneo and Texas, and the residual oils of the Caucasus and Burmah. The ultimate analysis of these oils is given in Appendix A (page 748).

It has been suggested by some of the early writers on the subject that liquid fuel has a higher calorific value than solid fuel of the same chemical composition, from the fact that a certain amount of heat has been rendered latent in passing it from the solid to the liquid form; and

Fig. 1. Vapour Burner (Dürr).

it has therefore been argued that heat values calculated on the basis of solid carbon are under-estimated to the extent of this latent heat of liquefaction. Dr. Paul, who investigated the subject very closely, has suggested 6000 British thermal units as the value of the heat thus lost; but as this is the value assigned by Rankine to the latent heat of the gasification of solid carbon, it would appear to be too high for the latent heat of its liquefaction. The determination of the heat value of petroleum by the bomb calorimeter does not show the existence of this latent heat, and Dr. Paul comes to the conclusion that it is not probable that petroleum, when used as fuel, can be made to evaporate more than about 16 lbs. of water from and at 212 deg. Fahr. This agrees with nearly all the well-authenticated results that are on record.

Taking Borneo oil as an example, some heat balance-sheets that have been experimentally obtained are given in Appendix B (page 748).

The heat lost in radiation was measured at a separate trial; the amounts thus found were interpolated in the balance-sheet, and found to agree very closely with the result found by difference in the usual way, in all cases but the second, when the observed evaporation was undoubtedly too high. The observed evaporation results were 15.4, 15.95, 14.6, and 14.48 respectively. The difference between the first and second pairs of experiments is due to the presence of water in the oil. This exercises a very important function in the behavior of the fuel, and is responsible for much of the difficulty that has attended its use. The actual reduction of the heat value of the fuel = 13.14 British thermal units per 1 per cent water, in addition to the loss of the oil which it replaces: for example, 1 lb. of oil mixed with 10 per cent water evolves

$$18{,}831 \times 0.9 = 16{,}947.9 \text{ British thermal units}$$

$$\text{less} \qquad 131.4 \quad " \quad " \quad "$$

$$= 16{,}816.5$$

a difference of 1915.5 British thermal units, or a loss in evaporative power of nearly 2 lbs. of water from and at 212 deg.

Besides this actual loss of heat, the presence of water destroys the conditions necessary for perfect combustion, and this occurs and may cause considerable damage to boilers of the ordinary marine type, although the quantity is not sufficient to extinguish the flame. The first effect is naturally to reduce the temperature of the flames and thereby increase their length, thus moving the point of highest temperature further into the furnace, which has the effect:

1. Of rendering a large portion of the furnace heating surface entirely useless.

2. Of raising the temperature in the combustion chambers to a point which may be hurtful to the material.

3. Of causing the last stage of combustion to take place in the smoke-box and funnel.

The conditions that attend and the reactions that take place in burning liquid fuel in boiler furnaces present a problem which has apparently not received the attention which it deserves. Petroleum vapor depends entirely on temperature, and it is therefore almost impossible to collect samples when actually burning it in a furnace. It seems obvious that the first effect of the furnace heat on the petroleum spray is to liberate hydrocarbon vapors, and to ignite them on the outer surface of the jet. The ignition raises the temperature of the whole of the jet, and probably dissociates some at least of the hydrocarbon vapors into carbon mon-

oxide and hydrogen. In what form the undissociated hydrocarbon vapors burn it is difficult to conjecture, but the appearance of the flames suggests that acetylene is present. This might conceivably arise from the reaction $CH_4 + CO = H_2O + C_2H_2$. As the temperature of the flame rises, the hydrocarbons are probably all dissociated and burn as CO and H to CO_2 and H_2O without further change. When the conditions are satisfactory, the flames are opaque and dazzling white in color for a distance of some 6 inches from the nozzle of the burner, become semi-transparent, and almost violet in color at the middle of their length, and shade into red at the end. In burning oil which is mixed with water the combustion is incomplete, the violet color never appears, and the end of the flame is dark red and fringed with smoke. In some cases, where water is present in comparatively small quantities, the end of the flame is white and presents the appearance of acetylene, which may arise from want of sufficient heat in the flame to decompose the hydrocarbons. This has been observed, when, although no smoke was formed, and the air supply was not more than 20 per cent above what is chemically necessary for the fuel, the evaporative performance of the boiler was poor, which confirms the existence of a low furnace temperature.

The "burners" which have been designed for admitting liquid fuel into boiler furnaces, numerous as they are, may be broadly divided into three distinct types. These are:

1. Mechanical spray, in which the liquid fuel is forced under pressure through nozzles, made of such a form as to break it up into a fine spray and thus render it inflammable.

2. Spray burners, where the liquid fuel is held in suspension and driven into the furnace by means of a jet of steam and compressed air.

3. Vapor burners, in which the liquid fuel is volatilized and the vapor admitted to the furnace.

So many of these burners have been designed by various inventors that it is impossible to describe more than one or two, which are typical of each of these three main divisions, without overstepping the limits of a paper, and in making his selection the author has endeavored, as far as possible, to treat of those that have stood the test of actual working at sea.

Of mechanical spray burners very few have achieved success. It is obviously very difficult to devise an apparatus which is capable of dividing into a fine spray a material so thick and viscous as fuel oil. The best known and most successful burners of this type are those of Messrs. Körting Brothers (Fig. 1, page 737). The oil is first heated to a temperature of 130 deg. Cent. and then forced under a pressure of about 50 lbs. per square inch through nozzles, each of which has a small orifice at the apex controlled by a central spindle with an enlargement of spiral form, so arranged as to impart a vortex motion to the oil as it passes through, of sufficient intensity to make it fly into spray by centrifugal force as soon as it issues from the nozzle.

Fig. 6, page 740, shows the way in which these burners are generally arranged, and the refractory lining to the furnace. Some such arrangement is necessary to maintain the temperature at a sufficiently high point to vaporize the fuel, and to prevent condensation of the flame before it has attained the temperature required to insure complete combustion. Another burner of this type is that of Mr. Swensson, of St. Petersburg (Fig. 2, page 737). Here the fuel passes through a minute

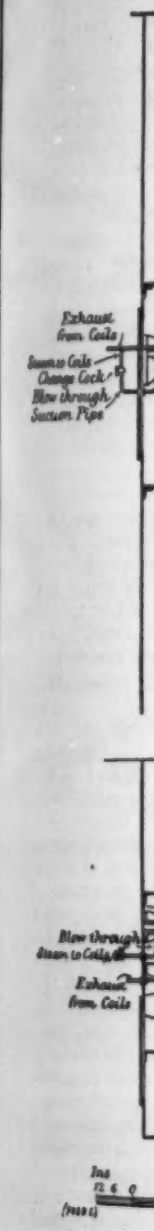
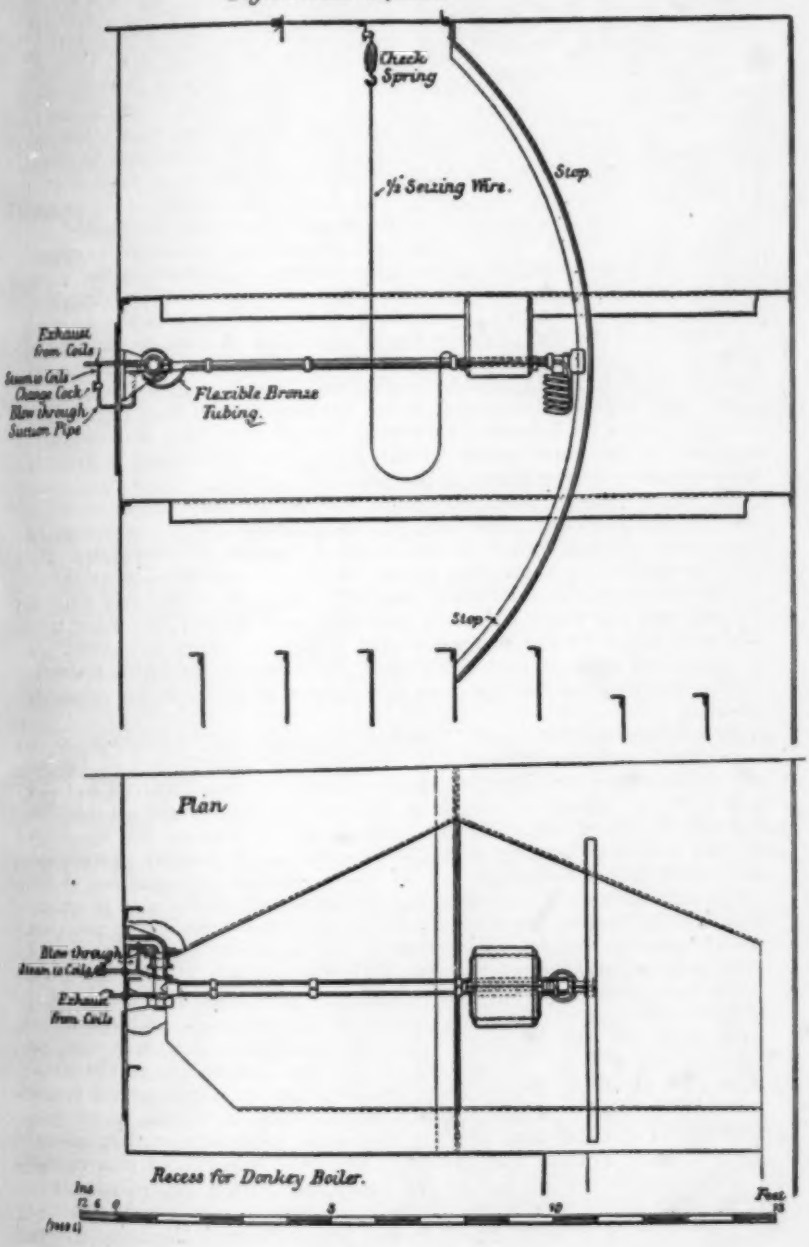


Fig. 6. Water Separator.



orifice, and is divided into spray by striking against a cutter placed at a short distance from the orifice. An adaptation of the Körting burner is used by Messrs. Howden, who have supplied some installations to boilers fitted with their well-known system of forced draft (Fig. 6).

The second type is by far the best known. Typical examples are: The Holden burner (Fig. 3), and the Rusden-Eeles burner (Fig. 4). Both these burners are designed to work with steam as the spraying medium, but in the Holden burner a current of air is induced by means of a ring of steam-jets outside the flame, which insures a rapid ignition of the outer layer of the spray, and a central current of air is also induced by the action of the jet of steam and oil passing from the burner.

The Rusden-Eeles burner (Fig. 4) is so well known as not to require a detailed description; it allows of separate adjustment to the steam and oil jets, and is in all respects a simple and workmanlike fitting.

Fig. 5 shows a burner designed by the author to vaporize as much as possible of the fuel to prevent any possibility of cracking the oil, and at the same time to sweep out in the form of spray any of the heavier products which might remain undistilled. The burner is designed to work with highly superheated steam (preferably 600 deg. Fahr.). The velocity of the jet induces a current of heated air, which insures instant ignition of the outer layers of the flame and consequent increase of temperature over the whole of the jet.

Of vapor burners pure and simple the author only knows of one at the present time—the Dürr (Fig. 7). Here there are two reservoirs for containing oil, etc., called by the inventor "gasifiers" (Vergäser). The smaller gasifier is heated by means of a fire, and as soon as the oil which it contains is sufficiently heated to give off vapor, this vapor is lighted, and the flame serves to heat the large gasifier, the vapor from which is burnt in the furnace of the boiler to which it is fitted. As soon as this flame is well established, the temperature inside the outer casing covering the two gasifiers is sufficient to maintain the vaporizing process.

In addition to the actual burning apparatus, no installation can be considered complete without (*a*) some form of filter to cleanse the fuel oil of impurities, and (*b*) some arrangement for separating water. This last is by no means so simple as it would at first sight appear. The specific gravity of most fuel oils is about 0.92 to 0.96, so that separation by the action of gravity alone is an exceedingly lengthy process, and practically never complete; but as the coefficient of expansion of fuel oil is considerably higher than that of water, the action may be greatly hastened by heating the contents of the tank; the combination of oil and water, however, is curiously intimate, and a careful experiment showed that at a temperature of 140 deg. Fahr. seven days elapsed before the water was completely separated. A large expenditure of heat is required if the contents of the fuel tanks are to be maintained at such a temperature, and it is obvious that, unless the separating process is complete and the water is all drained out of the tank before any of the fuel is drawn off for use in the burners, the lower layers, which are the first to flow, are formed of a concentrated intermixture of oil and water. One way out of this difficulty consists of a swing pipe supported at one end by a floating vessel. The orifice of the pipe is arranged at a suitable distance below the surface of the liquid fuel, and a coil of steam pipe is fitted so as to raise the temperature of the oil immediately surrounding the opening into the pipe; the fuel passes through the swing pipe on

its way to the burners, and is to a great extent freed of water at a comparatively small heat expenditure (Fig. 8).

It is impossible within the limits of a paper to describe fully the various arrangements that have been designed for burning liquid fuel, and the author would refer those who wish to pursue the subject to the writings of M. Bertin. The actual results obtained by successful installations of burning apparatus on sea-going steamers are somewhat difficult to obtain, but owing to the courtesy of the Shell Transport and Trading Company, the Burmah Oil Company, and Messrs. Körting, the author has been enabled to give figures showing the actual consumption of liquid fuel in practice as exemplified by mechanical and steam spray-burners. It is obviously impossible to draw any exact comparison between solid and liquid fuels without complete trials carried out in such a way as to show the actual boiler performance, and there are, unfortunately, no available data which allow of this being done properly from a scientific point of view. Commercially, however, the results have some value, and to make the comparison as useful as possible, the corresponding consumption of coal as actually ascertained is given in four cases.

Name of Ship.	Type—Burning Installation.	Consumption per Indicated Horsepower per Hour in Pounds.	Corresponding Consumption of Coal.	Heating Surface.	Indicated Horsepower.
C. F. Laiesz....	Körting.	1.408	1.93	7560	2200
Sithonia.....	Howden.	1.069	1.49	....	2500
Murex	Busden-Eeles.	1.3 ? / 16 tons*	25 tons.	5202	.....
Syriam.....	" "	1.32	....	2480	800
Khodoung ..	The Author. / Armstrong. / Whitworth&Co	1.08	1.67	2700	960

*The consumption in this case is given in tons per day. From Sir Fortescue Flannery's paper in the Transactions of the Institution of Naval Architects, 1902. No indicated horsepower was given.

Differences in consumption in favor of liquid fuel as compared with coal:

	Per cent.
C. F. Laiesz	say 27
Sithonia	" 28.6
Murex	" 36
Khodoung	" 35.5

All the vessels have triple-expansion engines of normal proportions, except the Sithonia, in which quadruple-expansion machinery is fitted, and from the coal consumption trial the amount of water required per indicated horse-power must be considerably less than in the other vessels referred to.

From the figures given above, it is evident that with a well-designed apparatus it is possible by good management to realize in actual practice the full difference in calorific value between liquid and solid fuel, at rates of evaporation such as are usually obtained in the boilers of vessels of the mercantile marine. At the higher rates of evaporation, such as required in war vessels, the problem becomes more complex;

but now that it is receiving the serious consideration of the Admiralty, there can be no doubt that a satisfactory solution of this most important question will be arrived at.

In presenting this paper the author, while conscious of its many shortcomings, hopes that it may serve to initiate a discussion in which more light may be thrown on the delicate problems involved in the combustion of liquid fuel than has hitherto appeared.

APPENDIX A.

Fuel Oils.

	Carbon. per cent.	Hydrogen. per cent.	Oxygen, &c. per cent.
Borneo	87.8	10.78	1.34
Texas	85.66	11.03	3.31
Caucasus	84.94	13.96	1.25
Burmah	86.4	12.1	1.5

The calorific values are:

	B. T. U.
Borneo	18,831
Texas	19,242
Caucasus	18,611
Burmah	18,864

These values are determined by the calorimeter.

APPENDIX B.

Heat Balance-Sheet of Borneo Oil.

Loss Due to Moisture.	Units of Evaporation.			
1. $\frac{10.78}{100} \times 9 \times (212-t) + 966 + 0.48\,(T-212)$ (where t = initial temperature of oil. T = temperature of escaping gases.	1.15	1.0	1.3	1.19
2. Losses due to heat carried off in escaping gases. $\frac{1+A^{12} \times T}{4000}$. (A = weight of air required for combustion (observed).	1.46	1.6	2.3	2.31
3. Loss due to radiation (observed)	1.3	1.4	1.3	1.35
4. Heat employed in evaporation	15.4	15.4	14.5	14.6
Total heat value of oil	19.4	19.4	19.4	19.4

LIQUID FUEL FOR STEAM PURPOSES.

The possibility of burning a liuid fuel with very great advantage in most circumstances as compared with a solid fuel has been so long recognized that it is astonishing the practice has not been more generally adopted. The success which has been gained in the last few years, however, will undoubtedly lead to a greatly extended use in the near future.

Naturally the choice of a fuel for steam raising is not altogether dependent upon the evaporative efficiency and other advantages which a particular one may possess, but will, of course, be largely influenced by relative market prices, and this, no doubt, has had considerable influence against the adoption of liquid fuel on a large scale in this country. The fuel natural to the locality will always have great advant-

ages over an imported fuel, and England, having such valuable coal supplies to hand, while on the other hand having no great natural sources of liquid fuel, gives preference to that material which renders it most independent of outside supplies. Although gas tar and oil gas refuse may be frequently employed in a very economical manner, yet there is little doubt that with a greatly extended use of liquid fuel the prices of suitable bye-products would be so enhanced that imported liquid fuel would remain practically in possession of the field.

For this reason engineers who have perfected the methods of burning liquid fuel have always considered the possibility of its use becoming limited in certain circumstances, and all modern appliances are so constructed that with slight trouble coal alone may be used in them to the best advantage. One of the great claims to be considered in favor of liquid fuel is the ease with which the burners can be extinguished and a coal fire substituted, thus enabling consumers to take every advantage of fluctuations in the prices of both fuels. For marine purposes this is most desirable, since at many ports liquid fuel would be far more economical to ship for boiler use than a suitable steam coal, while a vessel trading from a port such as Cardiff or Newport would naturally replenish her bunkers with the steam coal at hand.

Any liquid hydrocarbon of sufficiently high flash point may be used as a liquid fuel; thus residues from many manufacturing processes may be utilized in an economical manner. Astatki, the residuum from petroleum distillation, has been extensively used in Eastern Europe, but tar oils and the oils from oil gas plants are frequently employed. These oils are especially suitable for locomotive work, since most large railways make oil gas in considerable quantities for lighting purposes, and, moreover, have exceptional facilities for transporting gas tar from small towns on their lines where it can be obtained at a reasonable cost. On the Great Eastern Railway this form of liquid fuel is largely employed. Crude petroleum, which has been treated to remove the more volatile constituents and so bring its flash point above the imposed limit for use as fuel, is now being imported into this country. The various methods of burning liquid fuel have been classified by Aydon as follows:

(1) Injection with compressed air (W. Bridges Adams, 1863; Tarbutt, 1885).

(2) Percolation through a porous bed (C. J. Richardson, 1864; Weir and Gray; St. Caire Deville), in which the liquid fuel percolates upward through a porous bed, accompanied by heated air (and sometimes steam also).

(3) Vaporization (Foote; Simm and Barff, 1865-67), the oil being vaporized from a small retort heated in the furnace, or in some cases (Dorsett, 1868-69; Eames, 1875) by a special external heater for the retort.

(4) Steam spray injection (Aydon, Wise and Field, 1865-67), in which the oil is sprayed into the combustion chamber by a jet of steam, while in the same time the burner is so constructed that air, heated if possible, is drawn in to supply the oxygen necessary for combustion.

Such a classification does not include burning in open troughs, a method first introduced by Wittenström about the year 1884, and which for many purposes in stationary boilers, furnaces, etc., has met with considerable success; or the more recent method of Körting, by direct injection of heated oil at considerable pressure.

Excepting in a few special cases, the steam spray injection method has been universally adopted. Various extravagant claims have been made for the chemical action of the steam, but it is not easy to see from a theoretical standpoint that it has any advantage over injection by compressed air. From a practical point of view, however, the steam spray is the more simple, since it dispenses with the auxiliary apparatus necessary for the supply of the air blast. On a locomotive, where economy of space is of importance and suitable water for the boilers is readily obtainable, steam spray injection is universal. For marine boilers the choice formerly lay between steam and air injection, each having certain advantages. Using steam injection, the auxiliary apparatus necessary for the air-blast is done away with, thus giving economy to space, while it has the disadvantage of requiring more condensed water from the evaporators to replace the steam used. On the other hand, the extra steam necessary for the air-blowers can be condensed and returned in the usual way to the feed water-pipe, but of necessity extra machinery has to be employed. With the introduction of the Körting system referred to above, and the success which has attended its use, notably on the Hamburg-American Line steamers, the marine engineer now has the choice of another method, and everything seems favorable to the extensive adoption of this new system in the future.

From the numerous estimations of the calorific value of different liquid fuels, we may approximately state that in centigrade units it has a value of 10,500, while for good steam coal a value of 8000 to 8500 may be taken. It will thus be seen that the liquid fuel has a decided advantage. The usual calculations of the theoretical heating value of a fuel fail to take one important factor into consideration, namely, the physical condition of the fuel. Thus the determined calorific value of carbon is always that of solid carbon, the value for hydrogen being obtained experimentally for hydrogen gas; but although in coal the carbon is in the solid form, it is certain that in liquid fuels it has undergone the first change in the passage of a solid to a gaseous condition, and consequently carbon in a liquid fuel will have a higher calorific value by just as much heat as would be required theoretically to raise solid carbon to the liquid condition. Aydon has estimated that this is equivalent to an expenditure of some 3500 calories.

It is, of course, impossible even with the most perfect appliances to obtain anything like the full heating effect of a fuel in any boiler, and the only real test of the value of competing fuels is their performance under similar conditions in practice. One is struck at the outset with the extremely contradictory figures which have been published to show the evaporative duty of liquid fuel, figures ranging from 46 lbs. of water per lb. of fuel burnt to 14 or 16 lbs. per lb. It may be taken, however, that in modern practice an efficiency of 15 lbs. by steam injection is a very fair result. Many comparisons have been made with coal in the same boilers and under the same conditions with results varying from 7 to 8½ lbs. of water evaporated per lb. of coal consumed. A valuable series of tests made by the Engineers' Club of Philadelphia in 1892 gave the following results:

1 lb. anthracite evaporated.....	9.7	lbs.	of water
1 lb. bituminous coal 10.14		"	"
1 lb. oil 36° B.....16.48		"	"
1 cu. ft. of gas 20 C. P.....	1.28	"	"

We are indebted to the carefully recorded results obtained by Mr. Urquhart on the Grazi and Tzaritzin Railway for probably the best published figures of the relative merits of solid and liquid fuels. In winter he found that liquid fuel was 41 per cent in weight and 55 per cent in cost better than anthracite coal; or, compared with bituminous coal, 49 per cent by weight and 61 per cent in cost better. This was under the worst climatic conditions, and, as might be expected, in summer better results still were obtained. It must be borne in mind that these figures were deduced from the work of a large number of engines.

The Canadian Pacific Railway find that liquid fuel in use on their steamers effects a saving of 56 per cent on the cost of coal firing.

In this country the pioneer of liquid fuel on our railways is Mr. James Holden and his company; the Great Eastern Railway has now more than sixty engines burning it, either alone or in conjunction with coal. In a note presented at the International Railway Congress in 1900, Mr. Holden gives the following particulars of express trains running between Liverpool Street and Cromer. The distance of 138 miles is covered in 175 minutes with a four minutes' stop, on a consumption of 14.4 of tar residues per train mile, and an equivalent of 5 lbs. per mile of coal, which is used in raising the steam necessary for starting the oil injectors. In the same paper it is stated that on railways working with wood fuel a saving of 50 per cent has been effected by burning liquid fuel. Through the kindness of Mr. Holden, the writer recently made a long run on an engine burning crude coal tar overa coal fire with the Holden steam injectors, and was impressed with the ease of maintaining a regular steam pressure and the freedom from smoke.

The South Eastern and other railways are now fitting engines for this class of fuel, and an oil-fired engine is used for shunting on the Central London Railway. Boilers are also being fitted for liquid fuel at Woolwich Arsenal, and its use is extending among private firms.

In the English shipping trade the pioneers have been Messrs. Samuel & Co., the managers of the Shell Transport Company, and a reference to the excellent performance of their vessel, the steamship Clam, will be found in a recent number of *Nature*. An interesting account of the record voyage under liquid fuel appears in the *Shipping Gazette* of February 13, the vessel being the steamship Murex, also belonging to the Shell Transport Company. This ship arrived at Thames Haven from Borneo via Singapore and the Cape on March 10, having steamed 11,830 miles on a consumption of 800 tons of prepared fuel. The average daily consumption was from 17 to 18½ tons, while the same vessel when under coal used from 24 to 25 tons.

The economy of cost in liquid fuel does not lie entirely in its superior evaporative value, for several other factors are all in its favor, and probably the greatest of these in the marine service is the reduction in the stokehold staff. Potter states that with fourteen tubular boilers (16 feet x 5 feet) twenty-five men were required for stoking with coal, but on the introduction of liquid fuel six men sufficed. On the steamship Murex, referred to above, while more than twenty stokers were required when under coal fires, only three were carried to attend the oil burners. When the cost of wages, food, etc., for the large number of stokers carried on an average liner are taken into consideration, the possibilities for economy by the adoption of liquid fuel, when it can be obtained at a reasonable price, are very great. In the Royal Navy,

where the stokers carried on a battleship run into big numbers, not only does liquid fuel tend to economy, but an even more important factor—the number of lives risked in an engagement—would be largely reduced. It is terrible to contemplate the fate of the engine-room staff in the event of one of our big ironclads being sunk by a torpedo or the ram of an adversary's ship.

For storage, liquid fuel has a slight advantage over coal. In general terms it may be said that one ton of liquid fuel will require 36 cubic feet of storage and steam coal from 43 to 45 cubic feet; but it must be remembered that coal bunkers have of necessity to be specially arranged for the easy delivery of the fuel at the stokehold level, whereas liquid fuel may be carried in places where the storage of a solid fuel is quite out of the question. By the adoption of some system of removing water from the oil, such as that of Flannery and Boyd, where two settling tanks are alternately employed, liquid fuel may be stored in water-ballast tanks and the fore and aft peaks of the vessel. Remembering that one ton of oil fuel has such a much larger evaporative efficiency than the same weight of coal, and, further, has advantages in storage, a very much larger cargo space can be reserved in a vessel, or in the case of the belligerent marine, with no greater total weight of fuel on board, a very greatly extended radius of action can be obtained.

A point in connection with coal as a fuel in steamships which is often overlooked is the large amount of inert material which must necessarily be carried in the bunkers; for example, a ship takes into her bunkers 2000 tons of steam coal (H. M. S. Queen, which was recently launched, has a coal capacity of 2040 tons), and taking a fair estimate of the ash of this coal at 5 per cent, it means finding space for at least one hundred tons of non-usable mineral matter, even assuming that the ash and clinker do not exceed the ash of the coal. In the case of liquid fuel, the whole amount stored is actually available as fuel, and there is no trouble with ash or clinker in the furnaces, or solid waste of any description to be got rid of.

On any vessel, and especially on a ship carrying passengers, the operation of coaling is a particularly disagreeable one. With liquid fuel there is really no inconvenience, for the oil can be pumped into the tanks in much less time than coal shipment takes, and, further, all the dirt associated with "bunkering" is avoided. At the present time it is well known that the Admiralty is carrying out experiments in coaling war vessels at sea, the collier being made fast astern and the coal hauled along a suitable transport arrangement. It would undoubtedly be a much simpler operation to transfer liquid fuel through a flexible hose of slightly greater length than the cables made fast between the two vessels, providing that an oil of reasonable viscosity was employed.

Even in a country possessing such splendid supplies of steam coal as England, liquid fuel is now making rapid headway, and this is not surprising when one considers the high prices reached for coal of all descriptions during the last two or three years. To be able to fall back on liquid fuel, when it can be obtained at a reasonable price, places the consumer in an independent position as regards the colliery proprietor, and the necessary fittings to enable this to be done are by no means costly. Coal at a fair price will probably always have the advantage over imported liquid fuel, but in countries entirely dependent upon imported fuel, the liquid form must in the future be the main supply, for bulk for bulk it is twice as efficient as any solid fuel, and,

moreover, its transport in suitable vessels is attended with far less risk than with coal cargoes shipped from a great distance. (J. S. S. Brame, in *Nature*.)—*Scientific American Supplement*, August 9, 1902.

SUBMARINE BOATS.

By HERBERT C. FYFE, in *Page's Magazine*.

All of these boats are capable of manœuvring as surface craft when in the "light" condition—*i. e.*, with ballast tanks empty, and they differ from the Whitehead torpedo (in reality, a crewless submarine), which immediately on being fired sinks beneath the surface, and remains beneath during the whole of its run. The first point, then, to be considered is the method of submersion. In the Fulton, Morse, and Narval the same plan is employed. The first operation is the admission of a certain amount of water into the ballast tanks in order to bring them to the "awash" condition—*i. e.*, with only the conning tower above water and with about three to five inches of water between the hull and the surface. In this condition the boat may, of course, be navigated, using her electric motor, and when it is desired to totally submerge her she is steered below the surface by means of horizontal rudders. In certain details the boats differ from one another. Thus the Narval class have double hulls, and some of the water tanks are placed between the two skins; in the other types the tanks are all carried in the interior, there being only one skin. Then, again, the disposition of the horizontal rudders varies. In the Holland they are always at the stern. In the Gustave Zédé there are six diving rudders carried on the sides, two forward, two in the center, and two aft. The Narval and Morse have each four side rudders, two forward and two aft.

The Fulton, Morse, and Narval have all a reserve buoyancy when submerged. The Goubet, however, belongs to the class which have no reserve buoyancy when under the water. Having been brought to the "awash" condition, the Goubet is sunk by the admission of a further quantity of water, and when she is running submerged, her total weight exactly equals the weight of water she displaces. In the other three types the weight is less than the weight of water displaced.

M. GOUBET'S BOATS.—The advantage of the "positive floatability" type over the "negative floatability" type lies in the fact that if anything goes wrong the former will at once rise to the surface. M. Goubet's boats are miracles of ingenuity, but they are tiny craft, and it is doubtful if, built on a larger scale, they would behave as well as they are said to do now. Even as it is, a glass of water added to the tank will—so it is reported—upset the stability of the craft. In all these vessels submersion is effected by the alteration of weight. It is also possible to effect submersion by the alteration of the volume of displacement, though keeping the weight constant by withdrawing "plungers," "cylinders," or "drums," which protrude when the vessel is floating at the surface. The first inventor to employ the latter method was André Constantin, who built a vessel during the siege of Paris, which was furnished with pistons working in two cylinders. On these being drawn in from the interior, the boat sank (theoretically) to the required depth. The actual trials were, however, not satisfactory.

THE NAUTILUS TYPE.—The Nautilus, of Messrs. Campbell and Ash, was submerged by alteration of displacement. Five cylinders were provided on each side of the vessel opposite to one another, so that they could be worked in pairs; the displacement could thus be varied by one or more of these pairs of cylinders being pushed out beyond the side to increase, or drawn in flush to decrease, the displacement.

The Nautilus underwent some trials in Tilbury Docks in 1888, and she sank with Sir W. H. White, late Chief Constructor to the Navy, and others on board. Unhappily, she went right down to the bottom and stuck in the mud, and the cylinders declined to out-thrust, because the power for working them, though amply sufficient for working in water, was not great enough to drive them in the mud, and the inventors had not taken into consideration the adhesiveness of mud. On Sir W. H. White's suggestion, those inside the vessel moved to the higher end of the craft, and the boat was lifted from the grip of the mud. The Nautilus type has not found favor with engineers, and has now passed into the limbo of forgotten failures. As Sir William White has pointed out in his "Manual of Naval Architecture," the weight of the vessel and its contents must be made to slightly exceed the weight of water displaced by the total volume of the vessel. This excess in weight causes a downward motion, rapidly accelerating unless checked; and the control of the descent so as to limit it to a specified depth is not easily affected by appliances which simply vary the displacement.

The submarine craft constructed by Mr. Thorsten Nordenfeldt belonged to the positive floatability type. They were brought to the "awash" condition by the admission of water ballast, but, instead of being steered below the surface by horizontal rudders, as are the Fulton, Morse, and Narval, they were sunk by means of propellers working in vertical shafts. In the first boat the propellers were fitted inside sponsons, but in the later ones they were placed in the fore and aft lines. Mr. Nordenfeldt did not believe in steering submarines down an inclined plane, and all his boats went down on an even keel. Thanks to recent ingenious contrivances, it is now quite simple and safe for a submarine to descend by steering downwards and all modern craft go under at an angle. There is one other method of submersion and that is to admit a certain amount of water and then to force the boat below by shifting a heavy weight, or weights, forward.

PRESERVING LONGITUDINAL STABILITY.—Having now discussed the various methods of sinking submarines, the question of preserving their longitudinal stability must be considered.

The Fulton, Morse, and Narval are lighter than the water when submerged, whilst the Goubet's weight equals its displacement, and the tendency of all these boats on the slightest provocation is to rise to the surface or sink to the bottom. The principal causes of disturbance have been summed up by Captain Hovgaard, in a paper entitled "The Motions of Submarine Boats in the Vertical Plane," read before the Institution of Naval Architects at the Annual Meeting in 1901:

(1) Faulty use of horizontal rudder. (2) Admission of water through leakages. (3) Expulsion of foul air and products of combustion. (4) Firing of torpedoes and projectiles. (5) Movements of crew. (6) Existence of free surfaces of liquid. (7) Movements of loose weights such as fuel. (8) Variations of buoyancy caused by varying density of sea-water. (9) Grounding and collision. (10) Variations in speed.

With regard to the firing of torpedoes, the Fulton type carry four compensating tanks, and as the torpedoes are fired water is admitted into these. Thus the stability of the submarine is preserved. As to (5) those who have had personal experience of travel in the Nordenfeldt boat report that when a greaser walked forward a coupel of feet in the engine-room the head would go down a little, the water would surge forward in the tanks, and she would plunge to the bottom unless checked in time. The Whitehead torpedo is kept at a set depth below the surface during its run by means of the combined movements of a hydrostatic valve and a pendulum, which by the aid of a "servo-motor," incline the horizontal rudders in the required direction. The movements of the submarine may be controlled either by the movements of the horizontal rudders or by the shifting of weights from aft to forward or *vice versa*. In the Fulton type three trimming tanks are provided—one forward, one center, and one aft—and these all help to preserve the longitudinal stability of the vessel.

The system employed by M. Goubet for the attainment of this end is as follows: At each end of his vessel is a large circular water-tank connected by a stout pipe, in the center of which rises a pear-shaped dome containing a pendulum, a rotary pump, and pipes connecting the two tanks. When the submarine shows a tendency to rise to the surface or to dive to the bottom, the pendulum swings forward (marking the extent of the deviation on a dial above the dome) and in so doing forms a connection between the motor and the accumulators; the motor then commences to work the rotary pump, and the water is pumped from the higher tank to the lower until the boat is brought to the level position again. The pendulum then swings straight and the electric current is cut off and the motor stops.

Motive Power.—The question of motive power need not detain us long. Every modern submarine is driven by an electro-motor fed by accumulators when running submerged, and until great improvements have been effected in these it is impossible to hope for much greater speed. Doubtless the accumulator of twenty years hence will be much lighter and much more powerful than are those of to-day. As to surface propulsion, the gasoline engine used in the Fulton type appears to give satisfaction, and if submarines are to increase in size, larger gasoline engines would probably propel them at higher speeds than are attained at present. The four-cylinder gasoline engine carried in the Fulton is rated at from 160 to 190 actual horsepower, and at from 320 to 390 revolutions per minute. Its net weight is 1300 lbs., its length over all is 9 feet 7 inches, and its total height above the crank shaft center is 5 feet 6 inches. In these engines the distribution of the cranks and the timing of the valves and igniters are so arranged that the operations in the four cylinders alternate, so that while one is at the expansion stroke, the other three are at the suction, compression, and exhaust strokes respectively. By this arrangement the engine is perfectly balanced, and vibration is reduced to a minimum.

Vision when Submerged.—Those who condemn the submarine boat because it is blind when beneath the waves are apt to forget that the modern craft is in reality a torpedo-boat, whose usual place is on the surface, but which is capable of sinking entirely out of sight for brief periods to fire torpedoes, to escape detection, and avoid the fire of the enemy's quick-firing guns. When in the "awash" condition the

submarine is steered from the conning tower, and when running thus she would be a very difficult object to hit. Having approached within a certain distance of her prey she would disappear, perhaps rising once for a second to take final bearings before launching her torpedoes. With regard to instruments for under-water vision it is difficult to gauge the value of these until they have been put to a practical test during manœuvres or in actual warfare. Some of the French submarines have, according to the French service papers, torpedoed ironclads, steering solely by the aid of their optical tubes and periscopes; but in bad weather and in the storm and stress of a naval engagement it would be difficult to make much use, one would imagine, of such aids to vision. If the submarine can rise quickly, take observations rapidly, and dive with celerity, it is not likely to run the risk of being "struck" by the spar torpedo of a swift destroyer. The optical apparatus employed in the British submarines is the "hyphydroscope," the invention of Sir Howard Grubb, F. R. S.

THE FUTURE OF THE SUBMARINE.—The submarine boat is to-day very much in the same position as the whitehead torpedo and the torpedo boat in the first stages of their development. The early Whiteheads had a speed of from 7 to 7½ knots, a range of 1000 yards, and a charge of 67 lbs. of guncotton, and they were exceedingly erratic in their behavior. Now they have a speed of over 30 knots, and their range is 2000 yards, their charge 200 lbs., of guncotton, and thanks to the gyroscope hydrostatic valve and pendulum, they can be run absolutely straight up to 2000 yards.

The Lightning, the first torpedo boat constructed by Messrs. Thornycroft, is a very poor affair when contrasted with a Viper or an Albatross, and as the torpedo and the torpedo vessel have developed so it is likely that the submarine boat will develop, and that the under-water craft of fifty years hence will be vast improvements on those of to-day.

As a weapon of defensive warfare the submarine has already shown its value, and it has probably rendered close blockade impossible. As a weapon of offense there is still room for great improvement. Its sea-keeping qualities will have to be improved and its speed increased before it will be capable of acting with a fleet. French submarines have, it is true, made long journeys and torpedoed vessels at a considerable distance from their "base," and during the coming summer there are to be combined manœuvres of French submarines along with torpedo craft against the battle squadron. These will be watched with interest by those who believe in the "coming of the submarine." A syndicate has lately been formed to take over the Goubet patents, and there are those who argue that the small craft could be hoisted on board battleships or in "mother-ships" and conveyed to foreign waters; on the other hand, many naval officers view the arrangement with distrust.

DETAILS OF BRITISH SUBMARINES, NOS. 1-5.—Length, 63 feet 4 inches; beam, 11 feet 9 inches; displacement submerged, 120 tons; I. H. P. surface, 160; I. H. P. submerged, 70; speed surface, 8 knots; speed submerged, 7 knots; radius of action surface, 400 knots; radius of action submerged, 28 knots; armament, 5 Whitehead torpedoes.

TORPEDO AND OTHER WAR VESSELS.—This invention relates to torpedo boats and chiefly to those of the submarine type; and its objects, among others, are to provide an improved firing valve for use in expelling a tor-

pedo, to enable a submarine boat to rise or sink quickly, and to ventilate efficiently the petrol tank of an oil motor-driven submarine boat. The firing valve comprises a cylindrical casing having an inlet for compressed air, and a coupling piece connecting the casing with the expulsion tube. In the casing is a piston backed by a spring and carrying a valve seated over the outlet leading to the expulsion tube and that can open inwards. When it is desired to expel a torpedo, compressed air is slowly admitted

Fig. 1.

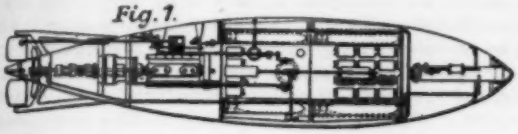
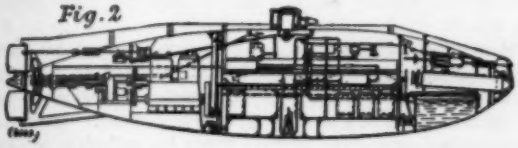


Fig. 2.



between the piston and valve and flows thence by a by-pass to the back of the piston, thus balancing the air-pressure on both faces of the piston. The by-pass is controlled by a two-way cock, and when, by means of this cock, the chamber behind the piston is open to the atmosphere, the unbalanced pressure forces the piston back and opens the valve, admitting compressed air to the expulsion tube behind the torpedo and expelling the latter. When the balance of air pressure is restored, the spring behind the piston closes the valve. The petrol tank has two vent tubes, one passing to the exterior of the boat and provided with a valve opening only outwards and serving to discharge any vapor that may have accumulated under pressure, and the other communicating with the interior of the boat, and provided with a valve opening only inwards, and serving to admit air to the tank to take the place of petrol expended. In order that the boat may rise quickly, water to the extent of about 1 per cent of the entire displacement may be ejected from a ballast tank by compressed air stored in vessels at a pressure of about 2000 lb. to the square inch. While the tank is refilling, in order that the boat may re-sink rapidly a diving rudder may be used.—*Engineering*, July 11, 1902.

WIRELESS TELEGRAPHY.

THE PROGRESS OF ELECTRIC SPACE TELEGRAPHY.*

By G. Marconi.

Wireless telegraphy, or telegraphy through space without connecting wires, is a subject which at present is probably attracting more world-wide attention than any other practical development of modern electrical engineering. That it should be possible to actuate an instrument from

*Lecture delivered at the Royal Institution, June 13.

a distance of hundreds or thousands of miles and oblige it at will to reproduce audible or visible signals through the effects of electrical oscillations transmitted to it without the aid of any continuous artificial conductor, strikes the minds of most people as being an achievement both wonderful and mysterious. If we examine the subject closely we may, however, come to the conclusion that, although telegraphy through space is certainly wonderful, as are likewise all natural and physical phenomena, yet it is certainly in no way more wonderful than the transmission of telegrams along an ordinary telegraph wire. The light and heat waves of the sun and stars travel to us through millions of miles of space, and sound also reaches our ears without requiring any artificial conductor. It is not, therefore, wonderful that man should have devised means by which he is enabled to confine electricity conveying messages or power to a wire and cause the effect which we call an electric current to follow all the turns and convolutions which may exist in the wire?

We find that the first systems of telegraphy used by mankind were truly wireless. A bonfire built on a hill by a band of aboriginal Indians conveyed a signal wirelessly by etheric waves—in this case light waves—to Indians on another hill, perhaps miles distant. Even to-day there are innumerable systems of what may truly be called wireless telegraphy in practical use. A red light at a railway crossing conveys a signal by waves through the ether to the eye of the engine driver. The red light is the transmitter, the eye the receiver.

The method of space telegraphy of which I intend speaking to-night is founded on a comparatively new way of controlling and detecting certain kinds of etheric waves, much slower in rate of vibration than light waves, called Hertzian waves, after the scientist who first demonstrated their existence. The mathematical and experimental proof by Clerk Maxwell and Heinrich Hertz of the identity of light and electricity, and the knowledge of how to produce and detect certain previously unknown ether waves, made possible this new method of communication. I think I am right in saying that the importance of the discoveries of Maxwell and Hertz was realized by very few, and even, perhaps, so recently as a year ago a great number of scientific men would have hardly foreseen the advances which have been made in so brief a time in the art of space telegraphy.

The time allowed for this discourse does not permit me to describe all the various steps which have made possible the results recently obtained nor to describe the work of the numerous workers who have contributed to the advance of the subject, but I hope it may be of interest if I describe the various problems which have lately been solved, and the very interesting developments which have taken place in my own work during the last few months. I shall first briefly describe my system as used in my early experiments six years ago, and afterward endeavor to explain the various improvements and modifications which have since been introduced into it.

The transmitter consists of a modified form of Hertzian oscillator, the main feature of which is in having one sphere of the spark discharger earthed and the other connected to an elevated capacity area or to a comparatively vertical wire. The two spheres are also connected to the ends of the secondary winding of an induction coil or transformer. When the key is pressed the current of the battery is allowed to actuate

the spark coil, which charges the spheres and the vertical wire, which, when discharging, causes a rapid succession of sparks to pass across the spark-gap. The sudden release caused by the spark discharge of the electrical strain or displacement created along certain lines of electric force through space by the charged wire causes some of the electrical energy to be thrown off in the form of a displacement wave in the ether, and, as a consequence, the vertical wire becomes a radiator of electric waves. In this connection it is interesting to remember that Lord Kelvin showed mathematically more than 40 years ago the precise conditions under which such a discharge as we are considering would be oscillatory. It is easy to understand how, by pressing the key for longer or shorter intervals, it is possible to emit a long or short succession of impulses or waves which, when they influence a suitable receiver, reproduce on it a long or short effect, according to their duration, in this way reproducing the Morse or other signals transmitted from the sending station.

The receiver consists of a coherer (on the nature of which I hope to make a few further remarks later) placed in a circuit containing a local cell and a sensitive telegraph relay actuating another circuit, which works a trembler or decoherer and a recording instrument. In its normal condition the resistance of the coherer is infinite, or at least very great, and the current of the battery cannot pass through it to actuate the instruments, but when influenced by electric waves the coherer becomes a comparatively good conductor, its resistance falling to between 100 and 500 ohms. This allows the current from the local cell to actuate the relay, which in turn causes another stronger current to work the recording instrument and also the tapper or decoherer, which is so arranged as to tap or shake the coherer, and in this way restore its sensitiveness. The practical result is that the circuit of the recording instrument is closed for a time equal to that during which the key is pressed at the transmitting station, and in this way it is possible to obtain a graphic, acoustic or optical reproduction of the movements of the key at the sending station. One end of the tube, or coherer, is connected to earth and the other to an insulated conductor, preferably terminating in a capacity area similar in every respect to the one employed at the transmitting station.

I noticed that by employing similar vertical rods at both stations, it was possible to detect the effects of electric waves, and in that way convey the intelligible alphabetical signals over distances far greater than had previously been believed possible, and by means of similar arrangements distances of transmission up to about 100 miles were obtained.

It was soon, however, realized that so long as it was possible to work only two installations within what I may call their sphere of influence, a very important limit to the practical utilization of the system was imposed. Without some practical method of tuning the stations it would have been impossible to work a number in the vicinity of each other at the same time without interference caused by the mixing of messages. The new methods of connection which I had adopted in 1898, i. e., connecting the receiving vertical wire or aerial directly to earth instead of to the coherer, and by the introduction of a proper form of oscillation transformer in conjunction with a condenser so as to form a resonator tuned to respond best to waves given out by a given length

of aerial wire—were important steps in the right direction. I referred at length to this improvement in the discourse which I had the honor to deliver at this table on February 2, 1900. I had, however, realized at the time that one great difficulty in the way of achieving the desired effect was caused by the action of the transmitting wire. A straight rod in which electrical oscillations are set up forms, as is well known, a very good radiator of electrical waves. In all what we call good radiators electrical oscillations set up by the ordinary spark-discharge method cease or are damped out very rapidly, not necessarily by resistance, but by electrical radiation removing the energy in the form of electric waves.

It is a well-known fact that when one of two tuning forks having the same period of vibration is set in motion, waves will form in the air, and the other tuning fork, if in suitable proximity, will immediately begin to vibrate in unison with the first. In the same way a violin player, sounding a note on his instrument, will find a response from a certain wire in a piano nearby, that particular wire, out of all the wires of the piano, happening to be the only one which has a period of vibration identical with that of the musical note sounded by the violinist. Tuning forks and violins, of course, have to do with air waves and wireless telegraphy with ether waves, but the action in both cases is similar. It is very important to take into consideration the one essential condition which must be obtained in order that a well-marked tuning or electrical resonance may take place. Electrical resonance, like mechanical resonance, essentially depends upon the accumulated effect of a large number of small impulses properly timed. Tuning can only be obtained if a sufficient number of these timed electrical impulses reach the receiver. As Prof. Fleming so graphically puts it in one of his lectures on electrical oscillations, to "set a pendulum in vibration by puffs of air we must not only time the puffs properly, but keep on puffing for a considerable period." It is, therefore, clear that a dead-beat radiator, i. e., one that does not give a train or succession of electrical oscillations—is not suitable for tuned or syntonic space telegraphy.

As I pointed out before a transmitter consisting of a vertical wire discharging through a spark-gap is not a persistent oscillator. Its electrical capacity is comparatively so small and its capability of radiating waves so great that the oscillations which take place in it must be considerably damped. In this case receivers or resonators of a considerably different period or pitch will respond and be affected by it.

Early in 1900 I obtained very good results with another arrangement in which the radiating and resonating conductors each take the form of two concentric cylinders, the internal cylinder being earthed. By using zinc cylinders only 7 meters high and 1.5 meters in diameter good signals could easily be obtained between St. Catherine's Point, Isle of Wight, and Poole, over a distance of 30 miles, these signals not being interfered with or read by other wireless telegraph installations worked by my assistants or by the Admiralty in the immediate vicinity. The capacity of the transmitter due to the internal conductor is so large that the energy set in motion by the spark discharge cannot all radiate in one or two oscillations, but forms a train of slowly-damped oscillations, which is just what is required. A simple vertical wire may be compared with an empty teapot, which, after being heated, would cool very rapidly, and the concentric cylinder system with the same teapot filled

with hot water, which would take a very much longer time to cool. In the receiver the closely adjacent cylinders which give it large electrical capacity cause it to be a resonator possessing a very decided period of its own, and it becomes no longer apt to respond to frequencies which differ from its own particular period of electrical oscillation, nor to be interfered with by stray ether waves which are sometimes caused by atmospheric disturbances, and which occasionally prove troublesome during the summer.

Another successful system of tuning or syntonizing the apparatus was the outcome of a series of experiments carried out with the discharge of condenser or Leyden jar circuits. I tried by means of associating with the radiating wire, or capacity, a condenser circuit, which is known to be a persistent oscillator, to set up the required number of oscillations in the radiator. An arrangement consisting of a circuit containing a condenser and a spark-gap constitutes a very persistent oscillator. Prof.

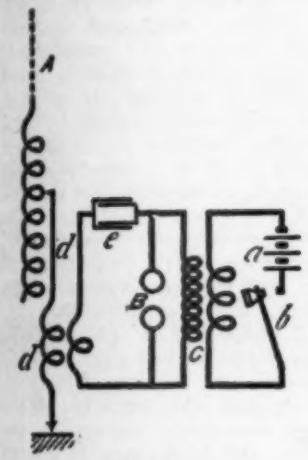


FIG. 1.

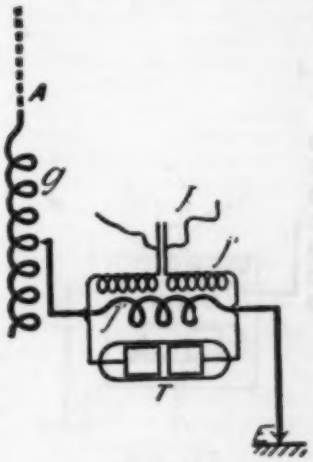


FIG. 2.

Lodge has shown us how, by placing it near another similar circuit it is possible to demonstrate interesting effects of resonance by the experiment usually referred to as that of Lodge's syntonic jars. But, as Lodge points out, "a closed circuit such as this is a feeble radiator and a feeble absorber, so that it is not adapted for action at a distance," I very much doubt if it would be possible to effect an ordinary receiver even at a few hundred yards. It is, however, interesting to notice how easy it is to cause the energy contained in the circuit of this arrangement to radiate into space. It is sufficient to place near one of its sides a straight metal rod or good electrical radiator, the only other condition necessary for long-distance transmission being that the period of oscillation of the wire or rod should be equal to that of the nearly closed circuit. Stronger effects of radiation are obtained if the radiating conductor is partly bent round the circuit containing the condenser (so as to resemble the circuits of a transformer).

My first trials with this system were not successful, in consequence of

the fact that I had not recognized the necessity of attempting to tune to the same period of electrical oscillations (or octaves) the two electrical circuits of the transmitting arrangement (these circuits being the circuit consisting of the condenser and primary of the transformer and the aerial or radiating conductor and secondary of the transformer). Unless this condition is fulfilled, the different periods of the two conductors create oscillations of a different frequency and phase in each circuit, with the result that the effects obtained are feeble and unsatisfactory on a tuned receiver. The syntonized transmitter is shown in Fig. 1. The period of oscillation of the vertical conductor *A*, can be increased by introducing turns of wire, or decreased by diminishing their number, or by introducing a condenser in series with it. The condenser in the primary circuit is constructed in such a manner as to render it possible to vary its electrical capacity.

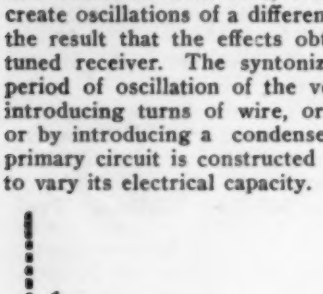


FIG. 3.

The receiving station arrangements are shown in Fig. 2. Here we have a vertical conductor connected to earth through the primary of a transformer, the secondary circuit of which is joined to the coherer or detector. In order to make the tuning more marked, I placed an adjustable condenser across the coherer in Fig. 3. Now, in order to obtain best results, it is necessary that the free period of electrical oscillation of the vertical wire primary of transformer and earth connection should be in electrical resonance with the second circuit of the transformer, which includes the condenser. I stated that in order to make the tuning more marked a condenser is placed across the coherer. This condenser increases the capacity of the secondary resonating circuit of the transformer, and in the case of a large series of comparatively feeble but properly timed electrical oscillations being received, the effect of the same is summed up until the E. M. F. at the terminals of the coherer is sufficient to break down its insulation and cause a signal to be recorded. In order that the two systems, transmitter and receiver, should be in tune it is necessary (if we assume the resistance to be very small or negligible) that the product of the capacity and inductance in all four circuits should be equal.

It is easy to understand that if we have several stations, each tuned to a different period of electrical vibration, and of which the corresponding inductance and capacity at the transmitting station are known, it will not be difficult to transmit to any one of them, without danger of the message being picked up by the other stations for which it is not intended. But better than this we can connect to the same vertical sending wire, through connections of different inductance, several differently tuned transmitters, and to the receiving vertical wires a number of corresponding receivers. Different messages can be sent by each transmitter connected to the same radiating wire simultaneously and received

equally simultaneously by the vertical wire connected to differently tuned receivers. This result, which I believe was quite novel at the time, I showed to several friends of mine, including Dr. J. A. Fleming, F. R. S., nearly two years ago. Dr. Fleming made mention of the results he had seen in a letter to the London *Times* dated October 4, 1900. I have further noticed that the tuning can be further improved by the combination of the two systems described. In this case the cylinders are connected to the secondary of the transmitting transformer, and the receiver to a properly-tuned induction coil, and all circuits must be tuned to the same period as already described. This arrangement is going to be further tested in long-distance experiments shortly to be undertaken between England and Canada.

The syntonic systems have not been applied generally to ships, as it has always been considered an advantage that each ship should be able, especially in case of distress, to call up any other ship or ships which may happen to be at the time within the range of its transmitter, but in the case of land stations the syntonic method has been applied in several instances where necessity demanded it. Thus at the testing stations which maintain communication between St. Catherine's, Isle of Wight, and Poole, in Dorset, when electric waves of a certain frequency are used, no interference whatever can be caused by the working of the Admiralty installations in the vicinity. The long-distance station at Poldhu, Cornwall, is able to transmit signals decipherable on a tuned receiver on a ship at over 1000 miles distance, while the Lloyd's wireless station at the Lizard, only 7 miles away, is not affected by the powerful waves radiated from Poldhu if tuned to a different frequency.

I am not at all prepared to say that under no possible circumstances could a wireless message transmitted between syntonic instruments be tapped or interfered with, but I wish to point out that it is now possible to work a considerable number of wireless telegraph stations simultaneously in the vicinity of each other without the messages suffering from any interference. Of course, if a powerful transmitter, giving off waves of different frequencies, is actuated near one of the receiving stations it may prevent the reception of messages, but the ordinary systems of communication through wires may be likewise affected. Prof. O. J. Lodge, in a report of his experiments in magnetic space telegraphy, mentions that he was able to interfere with the working of the ordinary wire telephone system in the city of Liverpool. Sir W. H. Preece has also published results which go to show that it is possible to pick up at a distance on another circuit the conversation which may be passing through a telephone wire. About two years ago, at Cape Town, it was found impossible to work the cables landing there during certain hours when the electric tramways of the town were running, and the matter become subsequently the subject of litigation between the companies concerned. Prof. Fleming, who has witnessed the working of a great number of syntonic wireless telegraph stations, was sufficiently impressed by what he saw to make the following statement in his Cantor lectures on "Electrical Oscillations and Electric Waves," delivered before the Society of Arts in December, 1900: "The objections as to interference of stations which imperfectly-informed persons are in the habit of raising with regard to Mr. Marconi's system of wireless telegraphy, as a matter of fact no longer exist."

I shall now say a few words on the subject of the detector of the

electric waves, called sometimes "the electric eye," which consists of that essential part of the receiving apparatus especially affected by the electrical oscillations. In all wireless telegraph apparatus used up to quite a recent date, a detector, now called a coherer, has been employed. This detector is based on discoveries and observations made by S. A. Varley, Prof. Hughes, Colzecchi, Onesti, and especially Prof. Branly. Prof. O. J. Lodge has made large use of this apparatus, which he first named "coherer," in the very numerous experiments and studies he has carried out on the effects produced by Hertzian waves. The form of coherer I have found most trustworthy and reliable for long-distance work consists of a small glass tube about 4 centimeters long, into which two metal pole-pieces are tightly fitted. They are separated from each other by a small gap, which is partly filled with a mixture of nickel and silver filings. Provided such a coherer is properly constructed, and the tapper and relay in good adjustment, it proves to be quite reliable when within the range of the transmitting station. Experiments with syntonic systems have, however, shown that certain kinds of coherers can be far more advantageously employed than others. One apparently all-important condition is that the resistance of the coherer in its sensitive state, or after being tapped, should appear to be infinite when measured with an E. M. F. of about 1 volt. If the tapping does not entirely do away with the conductivity of the filings very poor results are obtained, which can be explained as follows. According to the systems I have described, electrical syntony between the transmitter and receiver is dependent on the proper electrical resonance of the various circuits of the transformers used in the receivers. The condenser and secondary of the transformer must not be partially short-circuited by the coherer, otherwise the oscillations cannot mount up or sum up their effect, as is essential in order to produce the difference of potential at the ends of the coherer necessary for breaking down its resistance; but the electrical oscillations will leak across the conductive coherer without causing it to record any signal. Of course, the condenser is short-circuited when the filings cohere under the influence of the received oscillations; but in this case the signal is already recorded, and the tapper at once restores the coherer to its non-conducting condition, and in this way restores its sensitiveness.

By using coherers containing very fine filings the necessary condition of non-conductivity when in a sensitive state is obtained. Coherers have lately been tried which will work to a certain extent satisfactorily without the necessity of employing any tapper or decoherer in connection with them. Nearly all are dependent on the use of carbon microphonic contact or contacts which possess the curious quality of partially re-acquiring spontaneously their high resistance condition after the effect of the electrical oscillations has ceased. This enables one to obtain a far greater speed of reception than is possible by means of a mechanically-tapped coherer, the inertia of the relay and tapper which are used in connection with it being necessarily sluggish in their action. In all these self-decohering coherers a telephone which is affected by the variations of the electric current caused by the changes in conductivity of the coherer is used in place of the recording instrument. It has not yet been found possible, so far as I am aware, to actuate a recording instrument or a relay by means of a self-restoring coherer. The late Prof. Hughes was the first, I believe, to experiment with and receive signals

on one of these coherers associated with a telephone. His experiments were carried out as early as 1879, and I regret that this pioneer work of his is not more generally known. Other self-restoring coherers were proposed by Profs. Tommasina, Popoff, and others, but one which has given good results when syntonic effects were not aimed at was (according to official information communicated to me) designed by the technical personnel of the Italian navy. This coherer, at the request of the Italian government, I tested during numerous experiments. It consists of a glass tube containing plugs of iron with between them a globule of mercury. Lieut. Solari, who brought me this coherer, asked me to call it the "Italian Navy Coherer." Recently, however, a technical paper gave out that a signalman in the Italian navy was the inventor of the improved coherer, and I was at once accused in certain quarters of suppressing the alleged inventor's name. I therefore wrote to the Italian Minister of Marine, Admiral Morin, asking him to make an authoritative statement, to which I could refer in the course of this address, of the views of the Italian Admiralty on the matter. The head of the Italian navy was good enough to reply to me by letter, dated the 4th inst., in which he makes the following statement, which I have translated from the original Italian: "The coherer has been with good reason baptized with the name of 'Italian Navy Coherer,' as it must be considered fruit of the work of various individuals in the Royal navy and not that of one." These non-tapped coherers have not been found to be sufficiently reliable for regular or commercial work. They have a way of cohering permanently when subjected to the action of strong electrical waves or atmospheric-electrical disturbances, and have also an unpleasant tendency toward suspending action in the middle of a message. The fact that their electrical resistance is low and always varying, when in a sensitive state, causes them to be unsatisfactory for the reasons I have already enumerated when worked in connection with my system of syntonic wireless telegraphy.

These coherers are, however, useful if employed for temporary tests in which the complete accuracy of messages is not all-important, and when the atttainment of syntonic effects is not aimed at. They are especially useful when using receiving vertical wires supported by kites or balloons, the variations of the height of the wires (and, therefore, of their capacity) caused by the wind making it extremely difficult to obtain good results on a syntonic receiver.

Coherers have long been considered as constituting almost the essential basis of electric space telegraphy, and although many other detectors of electric waves existed, none of them possessed a sensitiveness which even approached that of a coherer, and most of them were also unsuitable for the reception of telegraphic messages. With a view to producing a receiver which could be worked at a much higher speed than a coherer, I was fortunate enough to succeed in constructing a magnetic detector of electric waves, based on a principle essentially different from that of the coherer, and which I think leaves all coherers far behind in speed, facility of adjustment and efficiency when worked in tuned circuits. This detector, which I had the honor of describing in detail before the Royal Society yesterday, possesses I believe a sensitiveness which surpasses that of the best coherers. The magnetization and demagnetization of steel needles by the effect of electrical oscillations has long been known and was noted especially by Prof. T. Henry, Aloria,

Lord Rayleigh and others. Mr. E. Rutherford also has described a magnetic detector of electric waves based on the partial demagnetization of a small core composed of fine steel needles previously magnetized to saturation. By means of a magnetometer Mr. Rutherford succeeded in 1895 in tracing the effects of his electrical radiator up to a distance of three-quarters of a mile across Cambridge. But Mr. Rutherford's arrangement is not suitable for the reception of telegraphic messages in consequence of the fact that a careful process of remagnetization, which requires some time to effect, is necessary in order to restore its sensitiveness after the receipt of each impulse. Mr. Rutherford's arrangement is also considerably less sensitive than a coherer.

The detector which I am about to describe is, in my opinion, based upon the decrease of magnetic hysteresis, which takes place in iron when under certain conditions it is exposed to the effect of high frequency oscillations or Hertzian waves. As employed by me, it has been constructed in the following manner: On a core of thin iron or steel, but preferably hard drawn iron, are wound one or two layers of thin insulated copper wire. Over this winding insulating material is placed, and over this, again, another longer winding of thin copper wire contained in a narrow bobbin. The ends of the winding nearest the iron core are connected, one to earth and the other to an elevated conductor, or they may be connected to the secondary of a suitable receiving transformer or intensifying coil, such as are employed for syntonic wireless telegraphy. The ends of the other winding are connected to the terminals of a telephone or other suitable receiving instrument. Near the ends of the core, or in close proximity to it, is placed a horseshoe magnet, which, by a clock-work arangement, is so moved or revolved as to cause a slow and constant change or successive reversals in the magnetization of the piece of iron. I have noticed that if electrical oscillations of suitable period be sent from a transmitter, rapid changes are effected in the magnetization of the iron wires, and these changes necessarily cause induced currents in the windings, which in their turn reproduce on the telephone with great clearness and distinctness the telegraphic signals which may be sent from the transmitting station. Should the magnet be removed or its movement stopped, the receiver ceases to be perceptibly affected by the electric waves even when these are generated at very short distances from the radiator..

I have had occasion to notice that the signals audible in the telephone are weakest when the poles of the rotating magnet have just passed the core, and are increasing their distance from it, while they are strongest when the magnet's poles are approaching the core. Good results have also been obtained by keeping the magnet fixed, and using an endless iron rope or core of thin wires revolving on pulleys (worked by clockwork), which cause the iron to travel through the copper wire windings, in proximity to, preferably, two horseshoe magnets with their poles close to the windings, care being taken that their poles of the same sign are adjacent. This detector has been successfully employed for some time in the reception of wireless telegraphic messages between St. Catherine's Point, Isle of Wight, and the North Haven, Poole, over a distance of 30 miles, also between Poldhu, in Cornwall, and Poole, in Dorset, over a distance of 152 miles, of which 109 are over sea and 43 over high land.

It would, no doubt, be possible to obtain signals by causing the iron

core to act directly on a telephone diaphragm, and in this case the secondary winding could be omitted. This detector, as I have already stated, appears to be more sensitive and reliable than a coherer, nor does it require any of the adjustments or precautions which are necessary for the good working of the latter. It possesses a uniform and constant resistance, and, as it will work with a much lower E. M. F., the secondaries of the tuning transformers can be made to possess much less inductance, their period of oscillation being regulated by a condenser in circuit with them, which condenser may be much larger (in consequence of the smaller inductance of the circuit) than those used for the same period of oscillation in a coherer circuit, with the result that the receiving circuits can be tuned much more accurately to a particular radiator of fairly persistent electric waves. As a call, a coherer in circuit, with a relay working a bell, can always be used, and if it is found possible to make the magnetic detector record on a registering instrument (as to the possibility of which the results of recent tests have left little doubt in my mind), it may be found possible to receive wireless telegraph messages at a speed of several hundred words a minute. At present, by means of this detector, it is possible to read about 30 words per minute.

The considerations which led me to the construction of the above-described detector are the following: It is a well-known fact that, after any change has taken place in the magnetic force acting on a piece of iron, some time elapses before the corresponding change in the magnetic state of the iron is complete. If the applied magnetic force be caused to effect a cyclic variation, the corresponding induced magnetic variation in the iron will lag behind the changes in the applied force. To this tendency to lag behind Prof. Ewing has given the name of magnetic hysteresis. It has been shown also by Profs. Gerosa, Finzi and others, that the effect of alternating currents or high-frequency electrical oscillations acting upon iron is to reduce considerably the effects of magnetic hysteresis, causing the metal to respond readily to any influence which may tend to alter its magnetic condition. The effect of electrical oscillations probably is to bring about a momentary release of the molecules of iron from the constraint in which they are ordinarily held, diminishing their retentiveness and consequently decreasing the lag in the magnetic variation taking place in the iron. I therefore anticipated that the group of electrical waves emitted by each spark of a Hertzian radiator would, if caused to act upon a piece of iron which is being subjected at the same time to a slowly varying magnetic force, produce sudden variations in its magnetic hysteresis, which would cause others of a sudden or jerky nature in its magnetic condition. In other words, the magnetization of the iron, instead of slowly following the variations of the magnetic force applied, gives a sort of jump each time it is affected by the electric waves emitted by each spark of the radiator. These jerks in the magnetic condition of the iron would, I thought, cause induced currents in a coil of wire of strength sufficient to allow the signals transmitted to be detected intelligibly on a telephone, or perhaps even read on a mirror galvanometer. The results obtained go to confirm my belief that this detector can be advantageously substituted for the coherer for the purposes of long-distance space telegraphy.

During the last few years the developments in the practical appliances of my system have been exceedingly rapid. Time does not allow me

to give you an account of the many cases in which it has proved its usefulness, but it may be sufficient if I mention that Lloyd's have adopted the system exclusively for use at their stations at home and abroad for a period of 14 years, and that no less than 17 liners plying across the Atlantic carry permanent installations. In more than one case recorded in the daily papers the system has been of service to vessels in distress, especially in the English Channel. No less than 40 land stations (most of which are controlled by the corporation of Lloyd's) are being equipped with the system in Great Britain and Europe, and over 40 vessels in H. M. navy carry installations. The adoption of my system in the Royal navy has brought about a certain slight change in the rig of the ships. Some naval officers believe that this change improves the ship's appearance; others think the contrary.

The Italian Admiralty, after experimenting for some time with the self-decohering coherers to which I have referred before, has informed me officially, by a letter dated May 24 last, of its decision to equip their war vessels with the same apparatus as has been successfully employed on the transatlantic liners. On these liners commercial use is made of the system for the convenience of passengers, and as an illustration of its commercial workableness I might mention that lately the Campania and Lucania of the Cunard line have been collecting as much as £60 each trip in receipts derived from passengers' wireless messages.

Nearly two years ago the facility with which communication was possible over distances of nearly 200 miles, and the improvements in syntonic methods introduced, together with the ascertained fact of the non-interference of the curvature of the earth, led me to decide to recommend the construction of a large power station in Cornwall and another one at Cape Cod, Mass., U. S. A., in order to test whether, by the employment of much greater power, it might not be possible to transmit messages across the Atlantic, and establish a trans-oceanic commercial communication which the monopoly of the Postmaster-General will not apparently permit between two stations if both are situated in Great Britain. An unfortunate accident to the masts at Cape Cod seemed likely to postpone the experiments for several months, when I came to the conclusion that while the necessary repairs there were being carried out I would use a purely temporary installation in Newfoundland for the purpose of a transatlantic experiment, from which I might, at any rate, be able to judge how far the arrangements in Cornwall had been conducted on right lines. Before describing the results it may be useful if I give a brief description of the nature of the apparatus used at the transmitting and receiving stations.

The transmitter at Poldhu was similar in principle to the syntonic one have already described, but the elevated conductor at the transmitting station was much larger, and the potential to which it was charged very much in excess of any that had previously been employed, the amount of energy to be used in this transmitting station having been approximately determined by me prior to its erection. The transmitting elevated conductor consisted of 50 almost vertical naked copper wires, suspended at the top by a horizontal wire stretched between two poles, each 48 meters high, and placed 60 meters apart. These wires were separated from each other by a space of about a meter at the top, and, after converging together, were connected to the transmitting instruments at the bottom. The potential to which these conductors were

charged during transmission was sufficient to cause sparking between the top of the said wires and an earthed conductor across a space of 30 centimeters of air. The general engineering arrangements of the electric power station erected at Poldhu for the execution of these plans and for creating the electric waves of the frequency which I desired to use were made by Dr. J. A. Fleming F. R. S., who also devised many of the details of the appliances for producing and controlling the electric oscillations. These, together with devices introduced by me, and my special system of syntonization of inductive circuits, have provided an electric wave-generating plant more powerful than any hitherto constructed. Mr. R. N. Vyvyan and Mr. W. S. Entwistle have also greatly assisted me in the experiments carried out with the very high tension electrical apparatus employed.

The first experiments were carried out in Newfoundland last December, and every assistance and encouragement was given me by the Newfoundland government. As it was impossible at that time of the year to set up a permanent installation with poles, I carried out experiments with receivers joined to a vertical wire about 400 feet long, elevated by a kite. This gave a very great deal of trouble, as in consequence of the variations of the wind, constant variations in the electrical capacity of the wire were caused. My assistants in Cornwall had received instructions to send a succession of "S's," followed by a short message at a certain pre-arranged speed, every 10 minutes, alternating with five minutes rest during certain hours every day. Owing to the constant variations in the capacity of the aerial wire it was soon found out that an ordinary syntonic receiver was not suitable, although a number of doubtful signals were at one time recorded. I, therefore, tried various microphonic self-restoring coherers placed in the secondary circuit of a transformer, the signals being read on a telephone. With several of these coherers, signals were distinctly and accurately received, and only at the pre-arranged times, in many cases a succession of "S's" being heard distinctly although, probably in consequence of the weakness of the signals and the unreliability of the detector, no actual message could be deciphered. The coherers which gave the signals were one containing loose carbon filings, another, designed by myself, containing a mixture of carbon dust and cobalt filings, and thirdly, the "Italian Navy Coherer," containing a globule of mercury between two plugs. For the good results obtained I was very much indebted to two of my assistants, Mr. G. S. Kemp and Mr. P. W. Paget, who gave me very efficient aid during the tests, which the extremely severe weather prevailing in Newfoundland made exceedingly difficult to carry out.

The result of these tests was sufficient to convince myself and my assistants that, with permanent stations at both sides of the Atlantic, and by the employment of a little more power, messages could be sent across the ocean with the same facility as across much shorter distances. The experiments could not be continued or extended in consequence of the action which the cable company, which claims all telegraphic rights in Newfoundland, saw fit to take at the time. Having received a most generous invitation from the government of the Dominion of Canada to continue my operations in the Dominion, it was thought undesirable to continue the experiments in Newfoundland, where I should have probably been landed into litigation with the telegraph company. I am glad to say that the Canadian government, on the

initiation of Sir Wilfred Laurier and Mr. Fielding, has shown itself most enterprising in the matter, and not only encouraged the erection of a large station in Nova Scotia, but actually granted a subsidy of £16,000 toward the erection of this transatlantic station, the object of which is to communicate with England from the coast of Nova Scotia. It is anticipated that the Canadian station will be ready for further tests very shortly. Another station for the same purpose is being erected on the United States coast.

Toward the end of February of this year I thought it resirable to test how far the messages transmitted by the powerful station at Poldhu could be detected on board a ship. The ship selected was the Philadelphia, of the American line. The receiving aerial conductor was fixed to the mast, the top of which was about 60 meters above sea level. As the elevated conductor was fixed, and not floating about with a kite, as in the case of the Newfoundland experiments, very good results were obtained on an ordinary syntonic receiver, similar to those I have already described, and the signals were all recorded on tape by the ordinary Morse recorder. Readable messages on tape were received up to a distance of 1551 miles from Cornwall, and indications were received as far as 2099 miles. Most of the messages were received in the presence of the captain or the chief officer of the ship, who were good enough to sign the tapes. I have some of these tapes here, in a frame, and they can be examined at the conclusion of my discourse. It is curious to observe that signals could not be received at over 900 miles by any of the self-restoring coherers. The reason for this lies probably in the fact that the tuned receiver when connected to a fixed aerial is more efficient. Another result of considerable scientific interest was that at distances of over 700 miles the signals transmitted during the day failed entirely, while those sent at night remained, as I have stated, quite strong up to 1551 miles, and were even decipherable up to a distance of 2099 miles. This result, which I had the honor of describing before the Royal Society yesterday afternoon, may be due to the dis-electrification of the very highly charged transmitting elevated conductor operated by the influence of daylight.

I regret time does not permit me to give you the views which have been expressed with reference to this phenomenon. I do not think, however, that the effect of daylight will be to confine the working of transatlantic wireless telegraphy to the hours of darkness, as sufficient sending energy can be used during daytime, at the transmitting station, to make up for the loss of range of the signals, and therefore this business of communicating across the Atlantic will not be one of those works of darkness with which some people connected with cable companies would seem disposed to class it. It is, however, probable that had I known of this effect of light at the time of the Newfoundland experiments, and had tried receiving at night-time, the results would have been much better than those that were obtained.

The day is rapidly approaching when ships will be able to be in touch and communication with the shore across all oceans, and the quiet and isolation from the outside world which it is still possible to enjoy on board ship will, I fear, soon be things of the past. However great may be the importance of wireless telegraphy to ships and shipping, I believe it will be of even greater importance to the world if found workable and applicable over such great distances as those which

divide Great Britain from her colonies and from America. Any of those who have lived in the colonies will easily appreciate what a hardship it is to have to wait, perhaps, four or five weeks before receiving an answer to a letter sent home. The cable rates are at present prohibitive to a vast majority of people. May it not, perhaps, be for wireless telegraphy to supply the want?

I apologize for having kept you so long, but I cannot help reading you, in conclusion, a short extract from a leading article in the London *Times* of Saturday, December 21, 1901, published at the time of the Newfoundland experiments. And I do so because it expresses in language of admirable clearness the sentiments with which I myself regard this subject: "It would probably be difficult to exaggerate the good effect of wireless telegraphy if, as Mr. Marconi and Mr. Edison evidently believe, and as the Anglo-American Company evidently fear, it can at no distant time be developed into a commercial success. The expense of telegraphy to distant countries is at present prohibitory to vast numbers of people, and even those who use it do so only in respect of matters of great urgency, or in which large money interests are at stake. The reason of the high charges must be sought, of course, in the enormous costliness of the plant, both in its original construction and in its maintenance and repair. A system of aerial telegraphy which would not require an expensive plant, and through which, therefore, messages might be sent at moderate rates, would soon become a potent agent in cementing those ties between Great Britain and the colonies which other recent events have done so much to strengthen and even to create. A system of comparatively cheap telegraphs would do for the British Empire very much what was done by the penny post for the United Kingdom. The pathetic story of Rowland Hill, whose efforts to establish cheap postage originated in the sympathy he felt for a poor girl in a Cumberland village who was unable to pay the sum demanded for a letter from her brother in a distant county, relates an event which in principle may be repeated to-day in many parts of the world. A cheap telegraph service would unite families, however scattered, would keep the dispersed members in close and constant touch with the old home, and would cement friendships between our own people and the colonial nations, besides forging another link in the ties which bind this country to the United States."

WIRELESS TELEGRAPHY—UNITED STATES NAVY.*

By Lieutenant A. M. Beecher, U. S. N.

The navy is on the eve of adopting a new system of signaling, commonly known as wireless telegraphy. We are all so familiar with the ordinary use of telegraphy between stations connected by conducting wires or cables, that the idea of doing away with these seems very strange at first. However, we have long known how to transmit signals from one point to another in a conventional language without a connecting wire between them. Thus visual signals, by means of flags, semaphores, or heliographs, by day, and searchlights, lanterns, or rockets, by night, have long been used. Sound signals using either steam whistle or gunfire are not uncommon, during either daylight or darkness,

*Paper read at the Annual meeting of the American Institute of Electrical Engineers, at New York May 28.

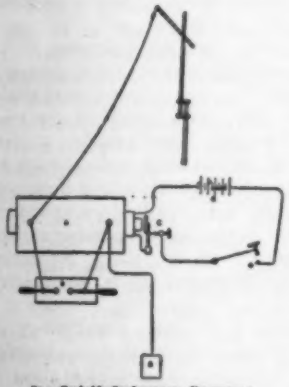
especially in thick or foggy weather. The only difference is that while with visual signals, light waves or vibrations are utilized, and in sound signals, sound vibrations, in wireless telegraphy, electric vibrations are put into requisition. In order to understand the mode of generation, propagation and reception of electric, or Hertzian waves, we can reason by analogy, and to that end it may be well to recall some well-known facts. A sound is the effect on the ear of a certain vibratory movement in the air, and we can distinguish sounds of different pitch according to their rate of vibration. When a sound is produced at any point it is transmitted to the whole elastic medium surrounding it, and is stopped or deadened only by soft bodies. Sound vibrations may be detected by the ear, or by placing in the path of the waves a body whose period of vibration is exactly the same as that of the source, thus a fiddle string will be caused to vibrate by sound waves given out by any instrument tuned to the same pitch, or a singer with a powerful voice, by singing loudly near a wine glass a note corresponding to its vibrating note, will cause the glass to vibrate, and this vibration may be so violent as to shiver the glass.

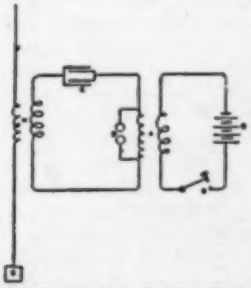
Light, like sound, is propagated by waves. The difference is that the medium (ether) which vibrates is not the same. The periods of vibration are considerably shorter, and the velocity of propagation enormously greater. Electric waves are also propagated in the ether, and are very closely associated with light waves. Hertz made a masterly study of these electric waves, and by his remarkable experiments has shown that they are propagated through all non-conducting media, and have most of the properties of light. They are reflected on conducting surfaces, are refracted in insulating bodies, and can be polarized. They travel at the same velocity as light, about 186,000 miles per second. It is seen, therefore, that there is a very close analogy between electric and light waves.

There are, however, certain properties of electric waves which are very different from those of light. Thus it is found that they are propagated not alone in straight lines, but that they also follow along the surface of conductors. They should not, however, be confounded with the other form of electric waves with which we are more familiar. I refer to electric currents. This property of these waves by which they follow along the surface of a conductor, explains many facts which have been noted in connection with wireless telegraphy. Thus it has been found that communication over salt water is much easier than over fresh water, and that signals can be sent over certain sections of land more easily than over others, or even than over fresh water. It is particularly difficult to get good wireless communication over sandy ground. In each case the ease of communication depends upon the conductivity of the intervening surface strata, whether it be land or water. This peculiarity of Hertzian waves also accounts for the fact that the curvature of the earth does not interfere with their propagation, so long as the intervening surface strata forms a conducting medium. These considerations tend to limit the field of wireless telegraphy to the ocean, and it is particularly fortunate that this happens also to be the place where wire communication is most difficult, or even impossible, as such cases as between ships.

Before proceeding to a brief description of the apparatus employed in wireless telegraphy, it should be pointed out how these Hertzian or electric waves are produced. As they are apparently so different from

the other variety of electric vibrations, the so-called electric currents with which we are familiar in conducting bodies. An electric current effects a comparatively slow equalization of potential between different portions of a continuous conducting circuit. On the other hand, Hertzian waves are generated by an electric spark or an electric discharge and are propagated through space without the aid of a closed circuit. It was shown by Prof. Oliver Lodge in 1876, and then again by Dr. Hertz in 1888, that such an electric discharge is not, as was long believed, a mere instantaneous leveling up of the difference of potential between the two electrified bodies, but rather that it takes the form of a series of surging waves, inconceivably rapid, oscillating until balance is restored. Moreover, it was shown that these surging waves were capable of setting up similar waves in conducting bodies in their vicinity, provided these bodies were of such electrical capacity as to be able to vibrate electrically at the same rate as the body which





emitted them. Such, then, are the waves with which we must deal in wireless telegraphy. From the fact that sparks are always necessary at the sending station, this form of signaling is sometimes called spark telegraphy. Hertz, who did more than any other man to elucidate the properties of these waves, cannot be considered the inventor of wireless telegraphy. Indeed it is difficult to ascribe the discovery to any one man, as, in its present form, so many different inventors have contributed to the final result. The sending apparatus is very similar in most of the systems so far produced. It consists essentially of an ordinary Ruhmkorff coil for generating sparks. Specially designed apparatus is generally used for making and breaking the primary circuit. A battery of cells is sometimes used in connection with accumulators or storage batteries for supplying power, but when available and where greater distances of transmission are desirable, a dynamo, either with or without accumulators, is commonly employed to excite the primary of the coil. In its simplest form the battery or dynamo is placed in the circuit with the primary winding, in which also the sending key (ordinary make and break) is inserted. One pole of the secondary

winding is then grounded, while the other is electrically connected to the aerial wire. These connections are shown in Fig. 1. These simple connections at the sending station are not now commonly used, but are somewhat complicated by employing an ordinary transformer and a condenser, a battery of Leyden jars, in addition to the apparatus first used. These are used in order to syntonize the apparatus. Fig. 2 shows one arrangement of connections when using the transformer and condenser.

Different arrangements have been adopted by inventors for varying the inductance and capacity, but no attempt will be made in this short paper to indicate these. The difficulty in obtaining thoroughly satisfactory results in so-called syntonized apparatus will be pointed out later when considering the receiving apparatus.

Various forms and arrangements have been used for the aerial. In most cases on board ship a single wire is used, carried by a sprit or gaff from the mast head. This wire, sometimes naked and sometimes with insulating covering, must be very carefully insulated with hard rubber or other efficient insulators at the mast head and at all other points where it might come in contact with metal portions of the ship. In some cases two or more wires are used, separated from each other by insulating spreaders, but joined electrically, to a single wire at the bottom before reaching the instruments. Wires arranged cylindrically have been tried, and metal cylinders have replaced the wires in certain cases. These various arrangements all serve the same purpose of radiating the electric or Hertzian waves when sending, or of receiving them when the proper connections are made with the receiving apparatus. It should be noted that a station cannot send and receive at the same time. There is greater divergence in the apparatus employed by different inventors for receiving than for sending wireless telegraphic signals. Still nearly all are following the same general lines.

Receiving apparatus may be classed under two general heads: First, those in which a coherer is used with a relay and Morse recording apparatus, and, second, those in which a loose contact or microphone is employed with a telephone receiver. In the latter case no relay is employed, and there is no recording apparatus, the message being received by telephone as a series of short or long buzzes, corresponding to the dots and dashes of the Morse code. We will briefly consider each of these different kinds of receivers, and, as the coherer is the one, and the loose contact or microphone is the other, are the essential features of each, they will be briefly considered.

The coherer was invented by Prof. Branly in 1890, and without it none of the present wireless telegraphic apparatus using a Morse recorder could have been made. It consists of two cylindrical metal plugs, usually made of silver placed in a glass tube with a certain short space between them partially filled with metal filings. Branly made the remarkable discovery that these metal filings ordinarily offer a high resistance to the passage of an electric current, but that under the influence of an electric spark, the resistance is enormously reduced, and the coherer then becomes a conductor, and remains so for a considerable time, or until mechanically decohered by being shaken or lightly tapped. The spark seems to cause the filings to arrange themselves end on forming metallic chains between the electrodes.

This effect of a spark is felt at a great distance, indeed it is impossible to tell the maximum distance at which it will be effective, but it is

safe to say that its influence will reach to a distance of 100 or 200 miles in well-constructed apparatus. A coherer inclosed in a metal box is not influenced by a spark, even if produced near by. If, however, wires connecting up with the electrodes are led out of the enclosing box, the coherer is again affected. This principle of screening the coherer is employed to keep it from being influenced by the sparks produced by the transmitting apparatus at the same station. The coherer is placed in a local circuit with a relay and single cell of low voltage. Under normal conditions the very high resistance of the coherer prevents current from passing, but under the influence of an electric spark, the resistance is broken down and the passing current actuates the relay. In the derived circuit is an ordinary Morse recording apparatus, and also an ordinary electric hammer which is arranged to tap the coherer gently and thus restore its high resistance by mechanically shaking up the filings between the electrodes. It was pointed out that an electric spark was not a single discharge, but rather a series of inconceivably rapid oscillations backward and forward between the terminal points until balance is restored. The periodicity and length of the waves thus sent out depend upon the capacity and inductance of the conductors discharged. By varying these, it has been sought to make certain transmitters affect only certain receivers, or in other words, to syntonize the transmitting and receiving apparatus, so as to make selective signaling possible. This has in practice been successful to only a very limited extent. In fact, it may be said that about the only result so far accomplished has been to increase the range of signaling; receivers whether in or out of tune being affected at shorter ranges. The difficulty seems to be due to the very high resistance of the receiving circuit. It takes so much energy to break down the resistance in a coherer, that the oscillations are damped or deadened after one beat. We may liken it to a pendulum swinging in molasses, the resistance of which will practically bring it to rest after a single swing. If this reasoning is correct we may not expect thoroughly satisfactory results in so-called syntonized apparatus using a coherer receiver.

We will now briefly consider the other form of receiving apparatus using a loose contact in place of a coherer, and a telephone in place of the relay and Morse recorder. There is a marked difference between these two methods of reception. A coherer being influenced only by electric potential must be placed at a potential loop, preferably at the top of the aerial receiving wire, while the microphone, or loose contact, should be placed near the earthing point of the aerial wire where there would be a loop or maximum of current oscillations. It is difficult to understand this difference, unless we remember that in the latter case using a loose contact, we also employ a telephone which is an extremely delicate instrument for detecting variations in current strength. A coherer might be used in place of a loose contact with a telephone receiver, but it is found in practice to be not nearly so sensitive.

The action of the loose contact seems to be that under the influence of the sparks the resistance of the circuit is changed without actually cohering the points and thus no decohering mechanism is necessary. This variation in the resistance causes an audible signal to be given out by the telephone. The signals consist of a succession of short or long buzzes, or musical tones, corresponding to the interruptions of the primary of the induction coil at the sending station.

In practice, various forms have been employed for these loose con-

tacts, such as two spheres, a sphere on a plate, a point on a plate, two or three points on a plate, or a kind of gridiron arrangement of bars crossing at right angles. In each case the principle is the same, that is, a change of resistance between the points of contact under the influence of the electric spark. A local circuit with telephone receiver is always used in connection with this loose contact or microphone, and the signal is received by telephone, as a succession of short and long buzzes corresponding to the dots and dashes of the Morse code. It has been proposed by some inventors to effect a mechanical tuning in addition to the electrical tuning when using a telephone receiver, by making the diaphragm of the telephone respond only to a certain velocity of the circuit breaker in the primary of the induction coil at the sending station. Prof. Fessenden, working under the direction of the United States Weather Bureau, has lately exhibited an apparatus using a telephone receiver, but employing an entirely different apparatus for varying the current strength, and thus producing audible signals. Unfortunately, I am not at liberty to explain his devices, but I believe that in some respects his apparatus is more reliable than that of other inventors. It was pointed out above, when speaking of coherer receiving apparatus, that the difficulty so far experienced in successfully tuning different sets seemed to be due, in a certain measure, to the high resistance of the coherer circuit, and the amount of energy necessary to break down this resistance. We might expect to be more successful in tuning apparatus in which a microphone and telephone receiver are used, as the resistance in the local receiving circuit in the latter case is not nearly as high as when using a coherer. Recent reports seem to show that this is the case, and that selective signaling can be carried on between several different sets of transmitters and receivers in the same vicinity, without interfering with one another. The great defect of the telephonic receiving apparatus has been the need of an efficient calling-up signal, and it is possible that the wireless apparatus of the future will take the form of a combination of the two different kinds of receiving apparatus, in which a coherer will be used in connection with a relay and electric bell for calling up, and a telephone receiver switched in for receiving the message. Such an arrangement would have many advantages, the most important being the greatly increased speed of sending and receiving possible when using a telephone receiver and at the same time the present unreliability of the coherer would not be so important when its use was confined solely to calling up, or rather to detecting a call from another station.

There is another kind of receiving apparatus sometimes used, differing from either of those mentioned before. In that an anti-coherer is employed in place of the coherer, and this is used both with a relay and Morse recording apparatus, and also with a telephone receiver. The action of the anti-coherer is exactly opposite to that of a coherer. Under normal conditions a certain resistance is maintained in the anti-coherer circuit. Under the influence of an electric spark this resistance is increased. The silvering on an ordinary glass mirror if scratched with a sharp point so as to separate the silvering into two portions, becomes an anti-coherer when these separate portions are connected up electrically in a receiving circuit. Under the influence of an electric spark the resistance to the flow of current across the scratch is increased. Other forms of anti-coherers have been invented. It is thought, however, that none of these have proved as reliable in practice as the coherer or loose contact.

Having thus briefly described in a general way the apparatus employed by different makers and inventors, I would like to point out what has actually been done, and what we expect to do, in the way of actually installing wireless telegraphic apparatus on board naval vessels. In the first place the masts of all ships are now being altered and prepared for the installation of wireless apparatus. This is a work of some magnitude as it necessitates increasing the height of the masts formerly used from about 120 feet to about 135 feet. The old height of 120 feet had been fixed as the maximum which could safely pass under Brooklyn Bridge. Of course, in the new arrangement, provision is made for housing the mast for this purpose. The upper portion of the mast, at least 50 feet, is of wood and is stayed with hemp rigging, or, in the case of rigging coming lower down than 15 feet from the mast head, it may be of wire set up with hemp lanyards.

Wireless telegraphic masts have also been erected at the Navy Yard, Washington; at the Naval Academy, Annapolis, and are being erected at the Navy Yard, New York; the Naval Station, Key West, and at Dry Tortugas. It is proposed to test thoroughly all the various kinds of wireless telegraphic instruments at these several shore stations and on board naval vessels, and after determining upon the system best adapted to varying service conditions, it will be adopted as the standard for the service and all naval vessels will be supplied with it.

It is needless to point out how greatly this new system of signaling will facilitate fleet manœuvres and operations, particularly in the way of supplying and communicating information gained by scouts, and the greatly enlarged field of action in which a single commander can, at all times, be promptly supplied with all important information, and can at the same time control and distribute his fleet to the best advantage.—*The Nautical Gazette*, June 12, 1902.

BOOK NOTICES.

"The Tactics of Coast Defense," by Major John P. Wisser, Artillery Corps, U. S. Army. Hudson-Kimberly Publishing Company, Kansas City.

Under this title Major Wisser has produced a very comprehensive work on a subject of the greatest interest and importance to both the army and navy. Since we began the defense of our shores according to modern ideas by rehabilitating the line of old forts and building new and better fortifications, many writers have dealt with one or more of the special divisions of this subject, but it has remained for this author to complete a treatise touching all the important branches, main and collateral, of coast defense.

For this work Major Wisser is peculiarly well fitted by his work on the staff of the Artillery School, as editor of the *Journal of the United States Artillery*, and at the Naval War College; and the effect of this preparation is shown in the depth of thought, breadth of research and intelligent treatment of the subject.

In naming the key points for the defense of our eastern coast the author omits Buzzards Bay and the Delaware entrance, which are certainly points of great importance in the chain of defenses, and on the west coast he omits San Diego, the only important harbor in Southern California and well outside the radius of action from San Francisco.

There is some confusion as to the nomenclature of the various types of fighting ships and this has led the author into several slight errors from a naval standpoint. For instance, he speaks of the necessity for coast defense ships as an auxiliary to the coast defense batteries. Our naval experts are practically agreed that no more vessels should be built solely for local coast defense, that the day of the low freeboard monitor is past, that the seagoing battleship best fulfils the requirements of coast defense, and in addition can steam and fight in all weather.

Under this head it may be noted that the author assumes that armored cruisers could be destroyed with rapid-fire guns of medium caliber. The first-class armored cruiser of to-day is in reality but little else than a high-speed battleship, and it would be safer to assign to the heavier guns of the shore defenses the task of destroying the armored cruisers of the enemy, leaving to the rapid-fire guns the small unarmored craft of the attacking fleet—the gun and torpedo boats.

The author's deductions as to the proper position for the outer mine field, based upon the most effective fire zone of the coast batteries, is ingenious and mathematically correct, but in nearly every harbor entrance or channel the depth of water will probably be the determining factor as to the mine fields.

As regards the style of mount to be used for the heavy coast defense guns the author rightly concludes that the barbette type is usually best adapted, and yet he defends the use of the disappearing mount on the ground of its easy concealment.

That guns mounted en barbette may easily be concealed from the attacking force is easily proved by the fact that guns so mounted at Gibraltar and St. Lucia are practically impossible to locate, even from the deck of a ship in the inner harbors, and that on May 1, 1898, it was only when the Baltimore was within 2500 yards of the Spanish barbette battery on Sangley Point that we were able to definitely locate the guns which were effectually screened by a growth of underbrush.

Chapter VI, on instruction and training, is an able discussion of the peace-time preparation for war, and lays stress on the necessity for constant, intelligent target practice with moving targets. This argument is sound and vital, for unless the artillery can shoot straight in all weather, both day and night, the most elaborate and expensive system of defense will fail in the hour of trial. Yet to one who has had a naval training it would seem a useless refinement to attempt aiming at any particular part of an attacking ship at battle ranges, 5000 to 10,000 yards. The navy practice of taking the waterline amidships as the target apparently promises better results with less liability of confusion from too much detail.

In this connection it might be well to suggest some actual "target practice" with mines, as there is a growing suspicion that the moral effect of the average mine is worse than the actual effect, and only experiment under conditions approximating war time can decide the question.

On the whole, the book is well written, the argument is logical, and should awaken among artillery officers, and naval officers as well, a growing interest in this important subject.

DION WILLIAMS, Captain, U. S. Marine Corps.

"Company Commanders' Manual of Army Regulations," by First Lieutenant William H. Waldron, U. S. Army. Hudson-Kimberly Publishing Company.

In this neat and compact little volume Lieutenant Waldron has compiled all of the information and references necessary for the administration of a company, troop or battery, in garrison or in the field.

As a reference book it should prove especially valuable in the field, where the books from which it is compiled would be very cumbersome; and to the Captains of the National Guard and Volunteers it will be of great value, giving them all the various administrative and clerical rules and regulations in a nutshell, and obviating the necessity of searching through many larger volumes for the same information.

DION WILLIAMS, Captain, U. S. Marine Corps.

"Lewis and Clark's Journals." History of the expedition under the command of Captains Lewis and Clark, to the sources of the Missouri, down the Columbia River to the Pacific in 1804-6. With maps. In three volumes. New Amsterdam Book Company, publishers, New York.

We have received from the New Amsterdam Book Company the three volumes of "History of the Expedition under the Command of Captains Lewis and Clark." These volumes are most tastefully and attractively gotten up, and would adorn any library. Instead of being a dry record of events, the story of this wonderful trip across the unknown continent is more interesting than the record of any of Stanley's trips across Africa. Countless stories have been written of the character

and the life of the Indians before they were influenced by contact with whites. This history, written by men of high scientific attainments as a government report, gives accurate and extended views of the Indians beyond the Mississippi when first seen by white men, of their dialects, pursuits, tribal customs.

The happenings of this wonderful across-continent trip are thrilling. The story of the adventures of these men would be interesting and hold high place if it were mere fiction. That it is a true record gives these volumes permanent place in American literature. These journals were first published in 1814; American literature is indeed enriched by the publication of these books in form accessible to all.

Mr. Davidge Page has established in London a high-class engineering journal, published monthly, under the name of *Page's Magazine*. From the first three numbers published it is evident that there is much money, allied with intelligence and experience, directing this new periodical. The magazine is something on the style of *Cassier's Magazine*, which will recommend it to the naval and engineering professions as well as to the general reading public. One very attractive feature is the division into different departments. A very prominent department is that entitled "Naval Notes," the readers of which will keep themselves well informed in construction and armament of all navies.

"Army and Navy Register." The Illustrated Supplement issued monthly with the current number of the *Army and Navy Register* is a most pleasing adjunct to that excellent periodical. The illustrations are always pertinent interesting, and artistic. We believe that this addition has been much appreciated by the naval service. The excellence of the *Register* is too well known to the naval service to need comment here. The editor of the INSTITUTE'S PROCEEDINGS has repeatedly received evidences of the *Register's* desire to co-operate in matters concerning the interest of the Institute, for which acknowledgment is here made.

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LIST OF PRIZE ESSAYS.

1879.

Naval Education. Prize Essay, 1879. By Lieut.-Com. A. D. Brown, U.S.N.

NAVAL EDUCATION. First Honorable Mention. By Lieut.-Com. C. F. Goodrich, U.S.N.

NAVAL EDUCATION. Second Honorable Mention. By Commander A. T. Mahan, U.S.N.

1880.

"The Naval Policy of the United States." Prize Essay, 1880. By Lieutenant Charles Belknap, U.S.N.

1881.

The Type of (I) Armored Vessel, (II) Cruiser best suited to the Present Needs of the United States. Prize Essay, 1881. By Lieutenant E. W. Very, U.S.N.

SECOND PRIZE ESSAY, 1881. By Lieutenant Seaton Schroeder, U.S.N.

1882.

Our Merchant Marine: The Causes of its Decline and the Means to be taken for its Revival. "Nil clarius aquis." Prize Essay, 1882. By Lieutenant J. D. J. Kelley, U.S.N.

"MAIS IL FAUT CULTIVER NOTRE JARDIN." Honorable Mention. By Master C. G. Calkins, U.S.N.

"SPERO MELIORA." Honorable Mention. By Lieut.-Com. F. F. Chadwick, U.S.N.

"CAUSA LATET: VIS EST NOTISSIMA." Honorable Mention. By Lieutenant R. Wainwright, U.S.N.

1883.

How may the Sphere of Usefulness of Naval Officers be extended in Time of Peace with Advantage to the Country and the Naval Service? "Pour encourager les Autres." Prize Essay, 1883. By Lieutenant Carlos G. Calkins, U.S.N.

"SEMPER PARATUS." First Honorable Mention. By Commander N. H. Farquhar, U.S.N.

"CUILIBET IN ARTE SUA CREDENDUM EST." Second Honorable Mention. By Captain A. P. Cooke, U.S.N.

1884.

The Reconstruction and Increase of the Navy. Prize Essay, 1884. By Ensign W. I. Chambers, U.S.N.

1885.

Inducements for Retaining Trained Seamen in the Navy, and Best System of Rewards for Long and Faithful Service. Prize Essay, 1885. By Commander N. H. Farquhar, U.S.N.

1886.

What Changes in Organization and Drill are Necessary to Sail and Fight Effectively Our Warships of Latest Type? "Scire quod nescias." Prize Essay, 1886. By Lieutenant Carlos G. Calkins, U.S.N.

THE RESULT OF ALL NAVAL ADMINISTRATION AND EFFORT FINDS ITS EXPRESSION IN GOOD ORGANIZATION AND THOROUGH DRILL ON BOARD OF SUITABLE SHIPS. Honorable Mention. By Ensign W. L. Rodgers, U.S.N.

1887.

The Naval Brigade: its Organization, Equipment and Tactics. "In hoc signo vinces." Prize Essay, 1887. By Lieutenant C. T. Hutchins, U.S.N.

1888.

Torpedoes. Prize Essay, 1888. By Lieut.-Com. W. W. Reisinger, U.S.N.

1891.

The Enlistment, Training and Organization of Crews for our Ships of War. Prize Essay, 1891. By Ensign A. P. Niblack, U.S.N.

DISPOSITION AND EMPLOYMENT OF THE FLEET: SHIP AND SQUADRON DRILL. Honorable Mention, 1891. By Lieutenant R. C. Smith, U.S.N.

1892.

Torpedo-boats: their Organization and Conduct. Prize Essay, 1892. By Wm. Laird Clowes.

1894.

The U.S.S. Vesuvius, with Special Reference to her Pneumatic Battery. Prize Essay, 1894. By Lieut.-Com. Seaton Schroeder, U.S.N.

NAVAL REFORM. Honorable Mention, 1894. By Passed Assistant Engineer F. M. Bennett, U.S.N.

1895.

Tactical Problems in Naval Warfare. Prize Essay, 1895. By Lieut.-Com. Richard Wainwright, U.S.N.

A SUMMARY OF THE SITUATION AND OUTLOOK IN EUROPE. An Introduction to the Study of Coming War. Honorable Mention, 1895. By Richmond Pearson Hobson, Assistant Naval Constructor, U.S.N.

SUGGESTIONS FOR INCREASING THE EFFICIENCY OF OUR NEW SHIPS. Honorable Mention, 1895. By Naval Constructor Wm. J. Baxter, U.S.N.

THE BATTLE OF THE YALU. Honorable Mention, 1895. By Ensign Frank Marble, U.S.N.

1896.

The Tactics of Ships in the Line of Battle. Prize Essay, 1896. By Lieutenant A. P. Niblack, U.S.N.

THE ORGANIZATION, TRAINING AND DISCIPLINE OF THE NAVY PERSONNEL AS VIEWED FROM THE SHIP. Honorable Mention, 1896. By Lieutenant Wm. F. Fullam, U.S.N.

NAVAL APPRENTICES, INDUCEMENTS, ENLISTING AND TRAINING. The Seaman Branch of the Navy. Honorable Mention, 1896. By Ensign Ryland D. Tisdale, U.S.N.

THE COMPOSITION OF THE FLEET. Honorable Mention, 1896. By Lieutenant John M. Ellicott, U.S.N.

1897.

Torpedo-boat Policy. Prize Essay, 1897. By Lieutenant R. C. Smith, U.S.N.

A PROPOSED UNIFORM COURSE OF INSTRUCTION FOR THE NAVAL MILITIA. Honorable Mention, 1897. By H. G. Dohrman, Associate Member, U.S.N.I.

TORPEDOES IN EXERCISE AND BATTLE. Honorable Mention, 1897. By Lieutenant J. M. Ellicott, U.S.N.

1898.

Esprit de Corps: a Tract for the Times. Prize Essay, 1898. By Captain Caspar Frederick Goodrich, U.S.N.

OUR NAVAL POWER. Honorable Mention, 1898. By Lieut.-Com. Richard Wainwright, U.S.N.

TARGET PRACTICE AND THE TRAINING OF GUN CAPTAINS. Honorable Mention, 1898. By Ensign R. H. Jackson, U.S.N.

1900.

Torpedo Craft: Types and Employment. Prize Essay, 1900. By Lieutenant R. H. Jackson, U.S.N.

THE AUTOMOBILE TORPEDO AND ITS USES. Honorable Mention, 1900. By Lieutenant L. H. Chandler, U.S.N.

1901.

Naval Administration and Organization. Prize Essay, 1901. By Lieutenant John Hood, U.S.N.

SPECIAL NOTICE.

NAVAL INSTITUTE PRIZE ESSAY, 1903.

A prize of one hundred dollars, with a gold medal, is offered by the Naval Institute for the best essay presented on any subject pertaining to the naval profession, subject to the following rules:

1. The award for the prize shall be made by the Board of Control, voting by ballot and without knowledge of the names of the competitors.

2. Each competitor to send his essay in a sealed envelope to the Secretary and Treasurer on or before January 1, 1903. The name of the writer shall not be given in this envelope, but instead thereof a motto. Accompanying the essay a separate sealed envelope will be sent to the Secretary and Treasurer, with the motto on the outside and writer's name and motto inside. This envelope is not to be opened until after the decision of the Board.

3. The successful essay to be published in the Proceedings of the Institute; and the essays of other competitors, receiving honorable mention, to be published also, at the discretion of the Board of Control; and no change shall be made in the text of any competitive essay, published in the Proceedings of the Institute, after it leaves the hands of the Board.

4. If, in the opinion of the Board of Control, the best essay presented is of insufficient merit to be awarded the prize it may receive "Honorable Mention" or such other distinction as the Board may decide.

5. Any essay not having received honorable mention, may be published also, at the discretion of the Board of Control, but only with the consent of the author.

6. The essay is limited to fifty (50) printed pages of the Proceedings of the Institute.

7. All essays submitted must be either type-written or copied in a clear and legible hand.

8. In case no essay is awarded the prize, the writer whose essay is first in order of merit will, if his essay has received honorable mention, be made a life member. Additional recognition of the merits of papers may be made by the Board at its discretion.

9. In the event of the Prize being awarded to the winner of a previous year, a gold clasp, suitably engraved, will be given in lieu of a gold medal.

By direction of the Board of Control.

E. L. BEACH,
Lieut., U. S. N., Secretary and Treasurer.